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STRATEGIC DEFENSE INITIATIVE

HEARINGS

BEFORE THE

SUBCOMMITTEE ON STRATEGIC AND THEATER
NUCLEAR FORCES

OF THE

COMMITTEE ON ARMED SERVICES
UNITED STATES SENATE

NINETY-NINTH CONGRESS

FIRST SESSION

OCTOBER 30; NOVEMBER 6, 21; DECEMBER 3, 5, 1985

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STRATEGIC DEFENSE INITIATIVE

WEDNESDAY, OCTOBER 30, 1985

U.S. SENATE,
SUBCOMMITTEE ON STRATEGIC AND
THEATER NUCLEAR FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

POLICY AND TECHNOLOGY OBJECTIVES

The subcommittee met in open session, pursuant to notice, at 9:05 a.m., in room SR-232A, Russell Senate Office Building, Senator John W. Warner (chairman) presiding.

Present: Senators Warner, Goldwater, Thurmond, Cohen, Quayle, Wilson, Nunn, Hart, Exon, Levin, Bingaman, and Glenn.

Staff present: Robert F. Bott, Douglas R. Graham, Robert G. Bell, William E. Hoehn, Jr., George K. Johnson, Jr., and Russel E. Milnes, professional staff members; Colleen M. Getz, research assistant; and Karen A. Love, staff assistant.

Also present: Gerald J. Smith, assistant to Senator Goldwater; Robert P. Savitt, assistant to Senator Cohen; James M. Bodner, assistant to Senator Cohen; Henry D. Sokolski, assistant to Senator Quayle; Mark J. Albrecht, assistant to Senator Wilson; Janne E. Nolan, assistant to Senator Hart; Jeffrey B. Subko, assistant to Senator Exon; John B. Keeley, assistant to Senator Levin; Edward McGaffigan, Jr., assistant to Senator Bingaman; and Milton D. Beach, assistant to Senator Glenn.

OPENING STATEMENT BY SENATOR JOHN W. WARNER, CHAIRMAN

Senator WARNER. The subcommittee will now come to order. Our witnesses have arrived and we recognize that each day they arise to be greeted by a new series of reports and articles concerning SDI, and it takes a little time to prepare to go public on these opinions.

We meet in open session this morning to receive testimony from administration witnesses on the policy and technology objectives of the Strategic Defense Initiative Program. This is the first of a series of hearings on the strategic defense initiative that the subcommittee will hold over the next 2 months. The intent of these hearings is to create a record based on a broad spectrum of views from both inside and outside of the administration that will serve as a reference for Senators in the coming year.

Among the issues to be taken up in these hearings will be the concerns expressed by the conferees in the fiscal year 1986 Defense Authorization Conference Report. These concerns will fall into three broad categories: First, the apparent disparity between the evolving administration policy with respect to strategic defense and the focus and scope of the SDI technology program; second, the role of limited defenses in the program and the relationship between these technologies and the more advanced technologies being pursued; and third, the relationship between the SDI technology program and the U.S. arms control policy, and particularly, the ABM Treaty.

The latter issue has been of considerable and continuing interest because of the central place that the SDI holds in the arms control positions of the United States and the Soviet Union as we approach the summit, and because of recent policy pronouncements regarding allowable testing under the 1972 Anti-Ballistic Missile Treaty.

We welcome this morning our witnesses, both of whom are well known to this subcommittee. Dr. Fred Ikle, the Under Secretary of Defense for Policy is here to provide testimony on the policy objectives of SDI, and we are glad to have you with us again.

Accompanying Dr. Ikle is Lt. Gen. James Abrahamson, the Director of the Strategic Defense Initiative Organization. General Abrahamson will address the technical objectives of the program.

Gentlemen, I understand that each of you have prepared statements, and I would ask you to present or summarize them as you see fit. Following any opening statement that the distinguished ranking minority member, my colleauge Mr. Hart will make, we would like to ask Dr. Ikle to begin.

And I now defer to the chairman.

Senator GOLDWATER. Mr. Chairman, as is my wont, I got up at 5 o'clock this morning, and reached outside the door and picked up my Washington Post. I read the headlines, and I began to wonder what would have happened if the Washington Post had been with us forever. I think we would not have automobiles. We would never had put a man on the Moon. We would not have had penicillin. We would not have had modern day panty hose. [Laughter.]

We would still have polio, and we would not do anything like a heart transplant, because that could never be done.

So I came to this meeting this morning just to have my confidence refreshed in the ability of America is to do almost anything they want to, the Washington Post notwithstanding.

So go ahead, Mr. Chairman.

Senator WARNER. Mr. Chairman, we hear you loud and clear.

I would like to express my appreciation to the distinguished ranking minority member, Mr. Hart, for the cooperation in planning the agenda for these hearings.

Senator HART. Mr. Chairman, the feeling is mutual. I appreciate very much your willingness and the chairman of the full committee to schedule these hearings. I know some may say that we have heard about all there is to hear about SDI and space defenses and the rest. I think one of the principal obligations of this committee on which it has been my honor to serve more than a decade is to continue to track the groundbreaking programs of our military forces, whether strategic or conventional, and all of us, I think, have much to learn about what the administration plans.

I think it is unfortunate that SDI polarized so much of the Congress and the country along political lines. It is unfortunate and unnecessary, and I hope that those of us who are neither pro-SDI nor opposed to SDI can continue to be heard. We await the technological evolution of this program as we have for many years, and we support the research that goes into it.

I think at this point those of us in that more or less neutral ground see no particular reason to polarize this question further. There are some serious questions arising because of the upcoming summit; our commitment, apparently continuing commitment to the basic elements of the Anti-Ballistic Missile Treaty and some confusion, I must say, on the part of those of us who are agnostic on this question about what the administration's policy is, where it feels the treaty drops the line between what is permissible and what is not, and any clarification on that question, Dr. Ikle, or others I think would be extremely helpful to many of us who I say are neither opponents nor proponents but continue to support ongoing research in this vast array of technologies.

And so I once again am pleased that the Senator from Virginia, Chairman Warner, has seen fit to continue to not only try to educate the committee, but also the American people on what could well be one of the most important, most dramatic areas of research and development that the military has undertaken in this century.

And I thank you, Mr. Chairman.

Senator WARNER. I thank the Senator from Colorado.

Mr. Cohen.

Senator COHEN. Mr. Chairman, I just have a couple of comments to offer.

I tend to associate myself with the comments made by Senator Hart in terms of the members of this committee being at least somewhat neutral on the issue of how far we should go with the SDI Program. I think a different element has been introduced in the last few weeks, and that is the connection between the SDI Program and the restrictions of the ABM Treaty, and I think it is fair to say based upon my experience on this committee that the administration has at least been lukewarm, if not indeed opposed, to the ABM Treaty in the past.

Secretary Weinberger, for example, has come before the committee on a number of occasions indicating that the ABM Treaty has failed in its objective because it was predicated upon the belief that we would restrain the offensive buildup in nuclear systems when in fact we have seen a dramatic buildup on the Soviet side and indeed somewhat of a buildup on our own.

But recently, in the last couple of weeks, we have seen a new interpretation being given to the ABM Treaty, and it seems to me that that poses a number of problems for us. If we do not like the treaty or we find it incompatible with our interests, then we ought to go back and either amend the treaty or repeal the treaty. But what seems to have occurred is that we have come up with a new tactic, and that is a sort of revisionist theory of history. We do not like it, so we therefore go back and reinterpret it in order to accommodate whatever plans we have.

Now, I have looked at the Congressional Record on this, and I find it somewhat interesting that if the administration's new interpretation of the ABM Treaty is in fact true, then we have something tantamount to a revocation of the New Testament, as such, or the King James version of the New Testament. We have got a situation in which every Member who voted for the ABM Treaty apparently did so for the wrong reasons. Those who voted for it believed that it did indeed prohibit research or, rather, testing and development in the field of space systems. Those who voted against it, interestingly enough—Senator Buckley was one of the two, as I recall, Members of the Senate who voted against the ABM Treaty—did so for the following reasons. He said, "Thus the agreement goes so far as to prohibit the development, testing, or deployment of sea, air, or space-based ballistic missile defense systems."

So even Senator Buckley, who voted against it, voted against it because he believed it prohibited space based systems.

So we have got a wonderful situation in which those who voted for it did so for the wrong reason and those who voted against it did so for the wrong reason, and that to me is not a plausible interpretation of what has taken place.

And so I think that we have to not only look at what is possible; I agree with Chairman Goldwater, we can do about anything with our scientific capability. The question is should we, and under what circumstances should we engage in revisionist history.

Senator WARNER. A very interesting statement, Mr. Cohen.

Mr. Bingaman.

Excuse me, Mr. Nunn. I did not see you.

Senator NUNN. No, go right ahead.

Senator WARNER. Senator Bingaman.

Senator BINGAMAN. I have no initial statement. I am glad to hear the testimony, Mr. Chairman, and appreciate the chance to sit in on the subcommittee.

Senator WARNER. Mr. Wilson.

Senator WILSON. Thank you, Mr. Chairman. I will not delay the proceedings long.

My good friend from Maine, though, has triggered an interesting discussion. Probably we should have it later and not at the expense of the witnesses. But having just returned from what is admittedly my first trip to Geneva, and having engaged one of the Soviet negotiators there in a discussion of the interpretation of the ABM Treaty, I was particularly interested when the deputy of our section, our defense and space section, later confirmed the judgment of Judge Sofaer that the record shows very clearly that the Soviet negotiators time and again were pressed by the American negotiators on the ABM Treaty to agree to the kind of restrictions that has become the common understanding of what the treaty held, and time and again they rejected that.

In a statement, the record shows that they did reject it. So I think this is not revisionism, I think there is a very clear case that can be made, and I think it has been made, not only by Judge Sofaer but by others who were very much privy to the negotiations. And it is Ambassador Hank Cooper to whom I refer.

But I think that the hearings that the chairman has called are vitally necessary. I think this discussion indicates the need for the hearings I think that what we want to be very clear about is that the United States is engaged in an effort to secure the kind of peace that is meaningful and that it does not engage in any kind of wishful thinking, either about what it can achieve technologically or about what it can achieve through the kind of impatience for agreement for which I think Americans are all too well known.

I think the fact that we have negotiated very little in the past year despite the pressure of SDI on the Soviets to come to some accommodation indicates how difficult that process is. I think the clearest lesson that we have had so far is the need for American patience, and American staying power. If we are to keep the incentive what it is at the present time until we have secured the kind of agreement that we are assured is verifiable, one that is worth a bargain, one that we can exact a cost for noncompliance from, we simply have to continue with the kind of program that is both permitted by law and permitted by resources. But I think the incumbent role of Congress is to see that we do not short those with the technological ability of the resources they require to do the job.

So with that, Mr. Chairman, I commend you for holding these hearings.

Senator **Warner**. Thank you, Mr. Wilson.

Mr. Levin.

Senator **Levin**. Mr. Chairman, just very briefly, I am delighted that you are holding these hearings. They are critically necessary at this time in our history. There has been a lot of confusion and division in the administration about the SDI Program, about the relationship of SDI to the ABM Treaty. Early after the announcement of the SDI system we were told by one party in the administration that SDI deployment, if it proved feasible, would be negotiable. Another party in the administration told us it would not be negotiable. We were then told recently that a new system such as SDI is not even covered by the ABM Treaty, a very stark departure from the prior representations of the SDI Office and this administration that they would comply with the ABM Treaty, and there was no suggestion in those earlier statements that new systems such as the SDI were not covered by the ABM Treaty.

So we have really had a flip-flop-flip on the question of the new systems being covered by the ABM Treaty. We do not even have agreement inside of the administration on the question of whether or not we are willing to negotiate clarifications in the gray areas in the ABM Treaty, some of the definitions that are not explicitly defined in the ABM Treaty. Part of the administration suggests there are gray areas that need to be negotiated. Other parts of the administration suggest that we will not negotiate any clarifications of the ABM Treaty.

So I think it is important to the public, to our negotiating position and to our allies that we get some clarifications as to where this administration is on the present status and future of SDI, both as it is unfolding technologically, but also as it relates to the ABM Treaty.

These hearings could not be more timely, and I commend the chairman for his willingness to hold them.

Senator **Warner**. I thank the Senator from Michigan, and indeed, you were among those that petitioned for these hearings.

At the present time Mr. Hart and I plan five sessions, this being the first. We will have on November 6 a closed session with the same witnesses present today. Therefore, we will be quite understanding if the witnesses wish to defer their responses to any inquiries from the Members of the Senate until such time as the closed session if in their judgment the responses would be classified.

On November 12 we will cover the issue of Soviet strategic defenses. On the 19th and the 21st we have tentatively, following the summit, two sessions primarily for the purpose of hearing from persons who have views somewhat at variance with yours, and also to assess the impact of the summit on the future of the program.

Senator NUNN. May I just make one brief comment, Mr. Chairman?

Senator WARNER. Yes.

Senator NUNN. I think these hearings are going to be very worthwhile and going to be very enlightening, and I congratulate you on the time schedule. I hope we can coordinate that with the hearings we are now setting on the reorganization matters. We have got 2½ weeks of those, and I know there are many members of this subcommittee, and I am one of them, and you are and Senator Hart and others, that want to be present for as much of those hearings as we can. So perhaps we can coordinate that.

Senator WARNER. Yes; the schedule has been coordinated with the chief counsel, and the minority counsel, as far as I know.

Senator NUNN. We will check on that.

Senator WARNER. Senator Thurmond.

Senator THURMOND. Mr. Chairman, I want to commend you for holding these hearings, and if there is no objection, I ask that my statement be placed in the record, and I have a few questions here. I will not be able to stay for the entire hearing.

I just want to commend you gentlemen for the great work you are doing with SDI. I think it is probably the most outstanding technology that has come before this country in my generation. If we can really develop SDI as now envisioned by you gentlemen and by the scientific world, there is no doubt it would be the turning point, I think, to bring peace in the entire world.

I remember when we went to the Soviet Union, there were eight Senators. The big point that Mr. Gorbachev dwelled on was SDI, demilitarizing space, he says. He emphasized that over and over again. He is afraid of SDI. If we develop SDI, then he sees that we can knock down his missiles, and he may feel helpless that he cannot carry out his domination of the world. And so I just want to say to you I hope you will keep developing SDI, as I think it is essential to preserving peace in the world. And I commend you for the great effort you are making.

[The prepared statement of Senator Thurmond follows:]

PREPARED STATEMENT BY SENATOR STROM THURMOND

Mr. Chairman, thank you for convening today's hearing concerning the Strategic Defense Initiative and the Anti-Ballistic Missile Treaty. I would like to add my welcome to Dr. Ikle and General Abrahamson. You gentlemen are no strangers here, and it is a pleasure to receive your testimony today.

The hearing notice indicates that the purpose of today's hearing is to receive testimony on the policy and technology objectives of the Strategic Defense Initiative. I certainly hope that the objectives of the program are as the President has already stated, and that is to render nuclear weapons obsolete.

The recent decision, however, to restrict our research and development programs to the narrowest interpretation of the ABM Treaty, while the Soviets are under no such constraints, casts serious doubt about our ability to reach our objectives in a manner consistent with our national security interests.

My interest in ballistic missile defense goes back nearly 30 years. In 1957, following early intelligence reports of Soviet ABM developments, I called for U.S. development of such a system, and in 1963, I requested the first secret session of the Senate since World War II so that my colleagues could be briefed on a Soviet prototype ABM system.

The ABM Treaty was seen as an historic breakthrough in the arms race in that it would make future arms reductions possible. That idea has proven miserably incorrect. So, it seems to me that it would be in our best interest to proceed with SDI at as rapid a pace as is technologically feasible.

Unfortunately, we have chosen not to do so by our announced intention to follow a restrictive interpretation of the ABM Treaty. I hope that Dr. Ikle and General Abrahamson will fully address the ramifications of this decision on the pace of our efforts. Thank you, Mr. Chairman.

Senator WARNER. Thank you, Mr. Thurmond.

Dr. Ikle.

STATEMENT OF DR. FRED C. IKLE, UNDER SECRETARY OF DEFENSE FOR POLICY

Dr. IKLE. Mr. Chairman, we appreciate very much your inviting us to this hearing, giving General Abrahamson and myself the opportunity to bring your committee up to date on the strategic defense initiative.

As I have stressed here before, Mr. Chairman, the strategic defense initiative is not an optional program at the margin of our defense effort. It is a key element in our long-term policy of enhancing United States and allied security and of reducing the risk of nuclear war.

During the 2½ years since the President announced this program, much of the controversy about it has been sorted out. Many of the questions I believe have been successfully answered. Of course, as in the case of any large, long-term-research program, a great many questions cannot be resolved for some time, and some disagreements will surely continue to enliven our debate.

At this time, the research program under the strategic defense initiative has already brought us encouraging results and developed clear priorities. General Abrahamson will discuss these with you. Likewise, our extensive consultations with the allies have generally gone well. And in Geneva, we have made a sustained effort to explain to the Soviet negotiators the scope and purposes of this initiative and to invite the Soviet Union to join us in a cooperative transition to a safer strategic order, a strategic relationship that would rely mainly on defensive instead of offensive nuclear arms.

But we must also keep in mind that the decision to introduce ballistic missile defenses and its timing is not up to us alone. Judging from past trends, it is not implausible that the Soviet Union will move ahead of us and of our alliance in some of these decisions.

The Soviet Union has always considered defense to be an important and natural part of its own national security. As you know, it has maintained and perfected its extensive air defense network, a great many underground shelters for its own leadership, a large civil defense program, and as our intelligence clearly shows, a vigorous research program on ballistic missile defense. This program covers many of the areas which our SDI Program will address. By all indications, these Soviet emphases on strategic defense will continue into the future.

The SDI is needed to respond to the Soviet programs. But that, of course, is not the only, nor even the principal purpose of the strategic defense initiative. The principal purpose for the program is to determine whether we can reduce and eventually eliminate the awful threat posed by ballistic missiles, whether we can establish a more secure strategic relationship in which the role of nuclear offensive arms will continue to diminish in importance.

Now, in anticipating the possibilities for effective ballistic missile defenses, we recognize full well that there would be a transition period during which the effectiveness of defenses would materialize gradually. By properly phasing this transition to increasing defensive capabilities, we can actually enhance deterrence and can avoid creating new risks of strategic instability. Effective defenses against ballistic missiles can have the potential of complementing significant reductions in offensive forces. And to the extent that the defensive systems can reduce the effectiveness and, thus, the value of ballistic missiles, they can also increase the incentive for negotiated reductions.

Because we do not view strategic defense as a means of establishing military superiority, deployment of defensive systems, in our view, would most usefully be done in a cooperative manner, coordinated between our alliance and the Soviet Union.

But our commitment to work on such a cooperative transition should in no way be interpreted as giving the Soviets a veto over our possible future deployments of strategic defense.

Mr. Chairman, I could continue to discuss the strategic and political implications of SDI in some detail, but I think it might be more useful to you and your colleagues if I responded to your specific questions. I do not want to take up your time by repeating what you know while failing to address issues that are of concern to you.

Let me just quickly sketch out some of the important issues.

One, if and when deployment becomes feasible and should be decided upon, how it might be phased.

Two, the kind of protection that would be provided by initial deployments of defensive systems.

Three, the likely Soviet reaction to possible defensive deployments. Will the Soviet Union be motivated to cooperate with us, or to seek to negate our defenses?

Four, the dual impact of missile defenses for the security of our allies: the implications of growing Soviet missile defenses, on the one hand; the potential benefits of defenses that protect the territory of our allies, on the other hand.

Five, the impact of strategic defense on the long-term military competition between East and West.

Lastly, our choices in nuclear strategy raise broader political and moral questions. The President has addressed those eloquently on many occasions. As he put it last week, in his address to the

United Nations General Assembly, "the United States seeks to escape the prison of mutual terror."

So let me stop at that point.

Senator WILSON. Thank you, Dr. Ikle.

We will hear from General Abrahamson, then open it up to questions.

STATEMENT OF LT. GEN. JAMES A. ABRAHAMSON, DIRECTOR, STRATEGIC DEFENSE INITIATIVE ORGANIZATION

General ABRAHAMSON. Mr. Chairman and members of the committee, it is a privilege to come back and to present to you some of the key questions that many have privately asked me and seem to come out again and again about the program priority and about its progress. And so I will touch briefly on the salient points regarding the SDI. In addition to that, we do have an unclassified version of some of our system results which could be available, but I will allow you to make that judgment after I briefly read—and I apologize for reading, but I think it is most helpful if I read this short statement.

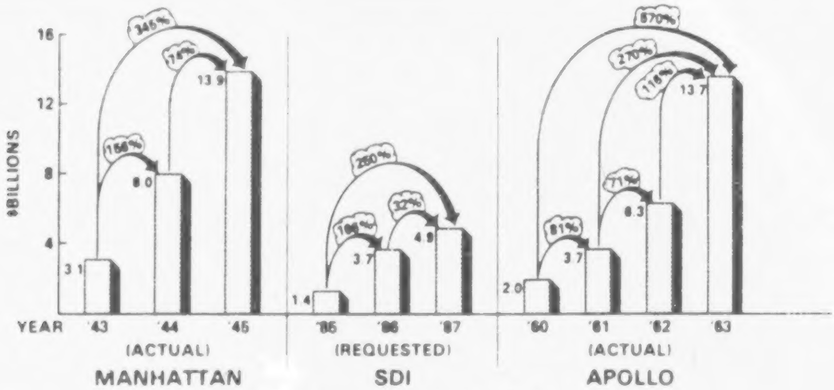
Since I last appeared, we have seen real progress in the program as well as changes. Because of cuts to our budget request, we have had to make some very difficult decisions with respect to technologies that will be more fully explored. We simply cannot afford to conduct the comprehensive, complete program of research that had been initially structured and afford that in the face of these reductions. At the same time, we have experienced significant breakthroughs in some areas which have also given reason to reorient certain of these priorities.

I would like to briefly highlight some of our program accomplishments and then discuss in a little more depth our objectives and our priorities.

Over the past year we have seen a program initiated with the myriad of problems associated with startup, combined with the tribulations attendant to a program of great magnitude and rapid growth. Some felt that it would not be possible to execute such a program, that the funding ramps were too great, that it was not feasible to absorb increases as budgeted. Comparisons with other programs of national priority belie these assertions. Growth in the SDI, even at the requested levels, let alone the authorized levels, is certainly no greater than at most points, and in most points less than growth in some of these like programs.

COMPARATIVE FUNDING

(85 DOLLARS)
SDI GROWTH LESS THAN
COMPARABLE NATIONAL PRIORITY PROGRAMS



[@ $2.75B AUTHORIZATION LEVEL,
'85 TO '86 RAMP = 96%,
'87 WILL NECESSARILY BE LESS]

I have included in the testimony a comparative funding chart that goes back to the Manhattan project that showed in the first 3 years of that program there was an overall growth of over 345 percent, a very dramatic increase. In the Apollo Program, in the first 4 years of that, I indicate the yearly steps of 570 percent. And our requested growth, by comparison, was 250 percent. At the authorization level it is substantially less.

Now, in order to be more specific rather than merely comparative, I go on to address the business activities that we have proceeded within the first year. We maintain an obligation rate for the SDI that exceeded other defense agencies throughout the year. Ninety-five percent of our program was obligated by the end of the fiscal year. This is a particularly noteworthy accomplishment that was underscored by the General Accounting Office's complimentary review and findings for Congress that validated this performance earlier in the year.

Obligations are not the whole story, however. Expenditure rates compared favorably with other research agencies, and I would like to underscore that research expenditure rates are different from large, ongoing programs that go from year to year, and other activities within the Department of Defense. For the year ending September 30, expenditures for the SDI as they were allocated and combined and collected at the top level in DOD were approximately 43 percent. We expect rates for activities similarly oriented toward research such as the Defense Advanced Research Projects Agency and the Air Force Strategic R&D Account to be slightly less than that of the SDI.

But even at that, we feel that our performance by this measure is better than the figures would indicate. Whereas obligations occur when contracts are executed or projects accepted, expenditures basically occur after consumption and sometimes years later. This is due to possible delays in billing, either by subcontractors to primes or to the Government directly, or delays in the accounting systems, delays in the payments process, and/or delays in our final data summaries at the top level. Because of this, we feel that the traditional measures, although important, are inadequate to reflect the effective use of our resources.

And if I could depart from the script, we saw that in the spring, and we began to take some special action with our various agents throughout the field, and to examine our accounting structure and our accounting systems to make sure that we did truly understand the right measures and that we could understand what our status truly was. Consequently, we are looking toward the use of a financial parameter that is much more closely related to performance for this kind of program. We call this measure noncancellable commitments. They are defined as costs incurred during a given period representing liabilities for goods and services received, other assets acquired, and performance accepted, whether or not payment has been made because, of course, at some point they must be made and they must be made against that fiscal year's appropriation.

We have applied this standard over the second half of this past fiscal year, and then a much more dynamic picture emerges. It is only an estimate at this point, but we estimate that nearly 90 percent of our funding has been dedicated to these noncancellable commitments. And I would emphasize that this is truly an exceptional accomplishment for a program of this scale in its first full year. I would also hasten to add that the credit rests not only with the program office but more importantly with the hundreds of agencies, firms, institutions and along with the thousands of individuals across America that are dedicated to the success of the President's initiative.

Now, I would like to touch on just a few of our significant technical achievements of the past year. We have had some genuine breakthroughs, and we have seen progress beyond that which was expected. For example, in the directed energy field, work with atmospheric compensation technologies has progressed to the point where it appears that the potential for large, effective ground-based lasers is very real. This clearly has important ramifications on the difficulty question of survivability as well as lethality. Those are two of the program's more important criteria because of the increased feasibility of ground basing as an effective approach for such defensive options.

Research with free electron lasers has progressed far more rapidly than anticipated with the possibility of jumping years ahead of what had been foreseen as recently as this spring. In addition, our test last month of the MIRACL chemical laser, the free world's highest average power laser, against a static Titan booster section, demonstrated graphically the lethality of this technology.

Similarly, we have had some very encouraging results from work with kinetic energy. These technologies are the more mature and hold the potential for some earlier options with respect to defensive systems. Electromagnetic launchers, or rail guns, may offer the possibility of firing small projectiles at extremely high speed that would home on and destroy a booster or warhead by impact. The ability to input high levels of power to these devices has been demonstrated far sooner than we expected. This means that heavier projectiles could be used and/or higher speeds attained. Overall, our work with rail guns has progressed more rapidly than we anticipated. Once more, all of this is a tribute to the dedication of the people in the field who make such results possible.

While I would like to continue enumerating our technical accomplishments, it suffices to say that they have been sufficient to cause a reprioritization in a number of our program efforts. At the same time, budget cuts have caused major, and I would emphasize major, revisions in our program. At the current authorization level, the program has been severely affected, and considerable changes have been forced. The result has been that the program has had to make premature down selection of certain key technologies. That is with great regret, I would add. Those are many promising technologies with teams of people that believe in what they are doing that have plans that will be affected, and it is with great regret, but we have to move into backup technologies. This will significantly increase our program risk and in some cases it will cause program slippage and delay completion, and certainly increase total cost.

For example, reduction in the number of contractors in any individual project will decrease competition and reduce our program scope. These reductions have left the program at a minimum level to study the complete requirements of a future strategic defense system.

Against this backdrop, then, I would like to review our program objectives and discuss our priorities as they are currently defined to support these objectives.

Overall, the SDI Program objectives are to develop a comprehensive R&D program to demonstrate key technologies for defense against ballistic missiles; to provide the basis for an informed full scale engineering development decision in the early 1990's; to protect an option of a near-term deployment of a limited ABM capability as a possible response to Soviet ABM breakout; to emphasize nonnuclear kill mechanisms; and last, but certainly not least, to provide an arms control environment conducive to substantial reductions in offensive nuclear weapons; and certainly to coordinate the SDI with our other defense programs and to support other strategic defense missions.

I would like to stress that there are many technologies and some specific programs that are required in other portions of our defense programs that are not funded in any other line except in the SDI line. Now, in order to effectively meet these objectives, the SDIO must expand and accelerate the progress of relevant technologies. It must identify and evaluate the potential effectiveness of candidate BMD defenses that could be assembled and deployed from these technologies while providing a basis for showing how such options could be operated and maintained to do the job. This must be done in the face of the very demanding criteria of cost effectiveness and survivability. Finally, all efforts must be conducted in full accordance with the applicable U.S. treaty obligations.

To accomplish these ends, I have established priorities for the SDI to best use our available resources. These priorities serve as the basis to guide my directors, as well as the activities in the services and in other agencies, in formulation and execution of their portions of the SDI to accomplish those above program objectives.

The first of these is that we must fully examine the multilayer architecture design and the major factors affecting the technology decisions, such as the survivability, lethality, countermeasures studies, affordability, and military strategy that go with those. It is essential to have the best possible understanding of these issues so that we can clearly chart the course for the program. Even though the resources devoted to this particular work are relatively modest, the importance of the results cannot be overstated. Nearly every element of the SDI is touched.

Second, we must explore to the greatest extent possible technologies that could support the ability to engage hostile ballistic missiles in the boost and postboost phases. This includes kinetic and directed energy weapons, early warning, acquisition, tracking, and pointing sensors; and certainly battle management, communications, command, control and our intelligence capabilities. The leverage afforded by the potential of defense in these stages of a hostile ballistic missile's flight is decisive. Conceivably, the highest payoff and the greatest return on defensive dollar investment would occur in these phases, before deployment of a missile's warheads and the associated penetration aids.

Next, data handling, along with command and control technologies for layered defenses must be investigated comprehensively and exhaustively. We currently are actively defining requirements in this area, as results emerge from our ongoing architecture studies. We must expand our ability to produce high performance, fault tolerant computing systems and supporting operating systems. Our ability to develop large and complex software systems to carry out the battle management mission functions must be enhanced. All this is done through analysis of communications network requirements, definition of the network architectures, and identification and development of the technology requirements. This will be followed by the development of a candidate system test bed, that is, on-the-ground test bed, and evaluation through simulation of these communications systems. Clearly this work is central to the concept of a layered defense against ballistic missiles. No matter what evolves from our research in other areas of the program, reliable, resiliant, and responsive data handling and command and control capabilities are requisite.

Beyond the boost and postboost realm, thorough examination of potential capabilities in other layers, and here I mean all the other layers, is needed. They are fundamental. Inquiry into the technologies that could support defensive approaches in the midcourse and in the terminal phases is critical. This includes kinetic and directed energy alternatives along with the tracking and discrimination sensor research that is required. You are all aware of the power offered by a layered defense and the advantage afforded the defender by the multilayered concept. To fully exploit this advantage, we must make available for our future leaders the widest range of defensive options along the entire spectrum of a ballistic missile's flight.

Now, success in nearly every element of the SDI is dependent on major advances in supporting technologies for spacepower, power conditioning, low-cost components, space transportation, and logistics. We must achieve rapid progress in these supporting technologies and innovative new concepts if viable alternatives developed throughout the program will indeed be feasible. Unprecedented magnitudes of power in space may be required for some of the possible defensive systems. It is essential to carefully consider affordability and specifically the mass to orbit weights across our entire program. Reliability, availability and maintainability obviously take on a new meaning in the environment of space. Indeed, all facets of logistics and supporting technologies demand careful attention from the outset. And I have directed all concerned to fully include these considerations in every quarter of their work.

Additionally, we must accelerate examination of potential applications to the shorter range missile threat. This is obviously of primary concern to our allies. Our security is inextricably linked to that of our allies. We will not confine ourselves solely to an exploitation of technologies with promise against intercontinental ballistic missiles or sea-launched ballistic missiles. We will also carefully examine the technologies with potential against shorter range ballistic missiles as well.

This does not represent an exhaustive list of activities in the strategic defense initiative. As I know you appreciate, there are a myriad of elements that have not been mentioned. This is not meant to denigrate in any way their meaning or their importance to the program. Instead, what I have tried to do is very briefly discuss those parts of the SDI to which I have assigned priority. These are the elements which we will try to more fully support in the face of limited resources to accomplish our overall objectives.

In a related vein, I would like to mention at least briefly the potential for spinoff and civilian application of the SDI research. We think this promise is great throughout all parts of the program. I am personally concerned that we not miss the splendid opportunity to capitalize on the results of the research of the SDI and apply it across all facets of our economy and society. For this reason, I have created within the SDIO the Office of Educational and Civil Applications. Among other things, its director will be responsible for developing and encouraging the widest possible use of SDI-related technologies, consistent with security considerations, for civil use, and helping to identify potential and existing technology applications and techniques that have economic benefits for the Nation.

I would like to just skip slightly to the key points that the Secretary has made in the past because I think this does offer a final perspective.

The aim of the SDI is not to seek superiority, but to maintain the strategic balance and thereby assure stable deterrence.

Research will last for some years. We intend to adhere strictly to the ABM Treaty limitations and will insist that the Soviets do so as well.

We have no preconceived notions yet about the defensive options that research may generate. We will not proceed to development and deployment unless the research indicates that the defenses meet strict criteria.

Within the SDI research program, we will judge defenses to be desirable if they are survivable and cost effective at the margin.

It is too early to speculate on the kinds of defensive systems, whether ground based or space based, and the best merits of each, although we are beginning to define them, and we have some initial ideas.

The purpose of the defensive options we seek is clear, to find a means to destroy attacking ballistic missiles before they reach any of their targets.

U.S. and allied security remains indivisible. The SDI Program is designed to enhance allied security as well as U.S. security. We will continue to work closely with our allies to ensure that, as our research progresses, allied views are carefully considered.

If and when our research criteria are met, and following close consultations with our allies, we intend to consult and negotiate, as appropriate, with the Soviets pursuant to the terms of the ABM Treaty, which provide for such consultations, on how deterrence could be enhanced through greater reliance by both sides on new defensive systems. This commitment should in no way be interpreted as according the Soviets a veto over possible future defensive deployments. And, in fact, we have already been trying to initiate a discussion of the offense-defense relationship and stability in the defense and space talks under way in Geneva to lay the foundation to support such future possible consultations.

It is our intention and our hope that, if new defensive technologies prove feasible, we—in close and continuing consultation with our allies—and the Soviets will jointly manage a transition to a more defense-reliant balance.

SDI represents no change in our commitment to deterring war and enhancing stability. We would deter a potential aggressor by making it clear that we could deny him the gains he might otherwise hope to achieve rather than merely threatening him with costs large enough to outweigh those gains.

For the foreseeable future, offensive nuclear forces and the prospect of nuclear retaliation will remain the key element of deterrence. Therefore, we must maintain modern, flexible, and credible strategic nuclear forces.

Our ultimate goal is to eliminate nuclear weapons entirely. By necessity, this is a very long-term goal, which requires, as we pursue our SDI research, equally energetic efforts to diminish the threat posed by conventional arms imbalances, both through conventional force improvements, and the negotiation of arms reductions and confidence building measures.

Again, I thank you for the opportunity to appear today and welcome your questions.

Senator THURMOND. General Abrahamson, would you allow an interruption?

Mr. Chairman, I have to go to another committee in just a minute to preside.

Would you permit me to ask one question right now?

Senator WARNER. Yes; of course.

Senator THURMOND. General Abrahamson, I just want to ask you this question. You have illustrated the funding profiles of SDI and the Manhattan project and the Apollo Program. Now you may have left out an important point that I thought might be worth bringing out. What would have happened to the Manhattan project and what would have happened to the Apollo Program if Congress had imposed the same spending constraints on them that Congress has imposed on the SDI?

Would you prefer to answer that for the record? It would be all right if you do, but I would like to have that question answered.

General ABRAHAMSON. Let me answer one thing that has to do with the process, sir.

Stability in planned programs is a key issue, stability meaning that we need to be able to plan a program and then to be able to conduct it with a longer timeframe than just a year.

Now, sometimes the technology and the progress warrant changes, and then we need the resources to be able to quickly exploit those so that we do not put resources into avenues that are not the ones that will pay off in the highest possible way. But when you have to replan the program on a continual basis, there are dramatic adverse effects. No. 1, the progress is slowed in these projects as you replan them and replan them. Second, you begin to lose the best people because these people want to make progress, they are dedicated to the program objective, and if they are frustrated in their ability to do that, then you not only have the program slowed, you lose some of the very best people. I can only speculate that if that happened in the Manhattan project and in the Apollo Program we would not have perhaps had the atomic bomb ready by the time that we needed it in World War II; and second, the amazing achievement of being able to go to the Moon in a decade would probably have been substantially delayed.

Senator THURMOND. Thank you very much.

Senator WARNER. Thank you, Mr. Thurmond.

Now, gentlemen, is there further direct testimony you wish to provide at this time? I know that you have a brief presentation on the architectural studies.

General ABRAHAMSON. Senator, it may be best in terms of the committee members to let you ask a round of questions.

Senator WARNER. The Chair proposes, in view of the fact that we have nearly 100 percent attendance of the subcommittee and we have several distinguished other members of our full committee, that we limit the first round of questions to 5 minutes and then proceed to a second round thereafter.

Would that be agreeable, Mr. Hart?

Senator HART. Yes, Mr. Chairman.

Senator WARNER. Thank you. I will lead off.

Dr. Ikle, one of the purposes of this series of hearings that Mr. Hart and I have structured is to really try and remove some of the points from the overall record of SDI that we in the Congress frankly feel to be somewhat incredible. This program has suffered, if I may say respectfully, from a credibility gap. The thing that has bothered me from the very earliest has been the representation that through this program we could, and I quote your testimony again today, eliminate, eventually eliminate the awful threat posed by ballistic missiles.

Now, I have had perhaps just a brief sojourn in this field since 1969 when I went to the Department of the Navy, that is, the field of atomic and nuclear weapons and so forth. I personally cannot subscribe that any level of technological success would meet the dictionary definition of eliminate. That means zero.

Now, I wonder if you would focus on that. Is that still a goal to which the administration is trying to guide this program?

Dr. **Ikle**. Mr. Chairman, I am glad you give us an opportunity to address this question. It is often asked. The objective here is to provide an open avenue for long-term development in the future where we can, through the defensive program, and when it becomes effective, reduce substantially the effectiveness, the military effectiveness and the mass destruction threat inherent in ballistic missiles.

To be specific beyond that, how you would, as you say, in a total sense eliminate the threat of ballistic missile is premature. One preferred course that we would like to follow, which has been enunciated by the President and the Secretaries of State and Defense, is to get into a cooperative program with the Soviet Union, a cooperative transition to reduce the threat. And it follows almost tautologically, if you have a phased transition of reducing offensive ballistic missiles, then phasing in defenses, that eventually these defenses can become totally effective.

If, however, say sometime in the next century, the Soviet Union would continue to oppose such a cooperative outcome—and I think there is reason to believe that a cooperative outcome is more likely than some people postulate—but if they continue to oppose, then it is possible that ballistic missiles could still penetrate some defenses, some missiles could still get through.

We cannot foresee the future with full certainty.

Senator **Warner**. I also share some skepticism on any future cooperation with the Soviet Union that would approach those goals, but that is a separate subject.

I would like to ask the General, from a technological standpoint, and that is your charter in this program, do you think it is an achievable goal that we can eventually eliminate the awful threat posed by ballistic missiles?

General **Abrahamson**. I think the importance of that goal is very similar to when President Kennedy set the goal to go to the Moon. He did not say let's go nine-tenths of the way or halfway to the Moon. He said let's go to the Moon.

What it means to us in the program, sir, is that it is our responsibility to search for architectures and for technologies that would provide a very robust kind of defense, one that we hope would be so effective someday, if these were exploited and developed, that it would indeed cause a Soviet targeteer, somebody on the other side, to not have sufficient confidence in his ability to get the numbers of ballistic missiles through so that he could achieve a military objective.

Now, I have said several times that nothing that we can do in life is perfect. On the other hand, we can look for the kinds of technologies and configurations that would be good enough to achieve a defensive level of deterrence, and that again is why the layered architecture is so important.

Senator **Warner**. Well, General, that seems to me to be a very reasonable explanation, but it does not embrace in my judgment the phrase "eventually eliminate."

Dr. **Ikle**. Mr. Chairman, this is a very important question, if I can get back to it again. I am glad you opened with it.

Senator **Warner**. I am sure you are.

Dr. **Ikle**. The threat of ballistic missiles, of course, as we now particularly are concerned about, is not the sneaking through of some nuclear weapons which could cause enormous disaster; but the threat of deliberate attack designed to disarm the United States, to achieve a strategic purpose, the kind of attack a rational decisionmaker might be tempted to order in a crisis.

We are not saying that we can make it technologically impossible that a nuclear weapon could be delivered in some way or another or smuggled in.

Senator **Warner**. No, we understand that.

Dr. **Ikle**. Second, on the point of a cooperative future transition with the Soviet Union, where we would work together to make it easier and more effective, while that may not seem that likely today, I agree with you, it is probably not around the corner.

Senator **Warner**. Well, I would suggest that you consider eliminating it from the text, but let me go on to a second question, and you can return to this, because I want to stick to the 5-minute rule, I would now like to go to the question of Mr. McFarlane on the Sunday that he made his interpretation of the ABM, and then back and forth, and eventually regravitated to the position, I think, that Secretary Shultz advocated. And quite frankly, I just want to ask, was that exchange between these two persons who are primarily charged with interpretation of that treaty, was that exchange a carefully calculated shot across the Soviet bow to indicate the direction which this country would take if the combination of summit sessions and Geneva negotiations failed to meet our objectives?

Dr. **Ikle**. Well, I do not want to interpret for other people what they would be more capable of answering.

Let me just say in a general sense that the reason why we arrived at this legal interpretation had nothing to do really with the anticipated meeting in Geneva as such. It was a result of receiving in the executive branch questions repeatedly from many Members of Congress and from others as to the exact meaning and scope of the treaty which led us to go back and do the legal research, and that in turn resulted in the answer that you heard. So that was really the sequence which led to this timing.

Senator **Warner**. And not a warning shot?

Dr. **Ikle**. Not the way I see it.

Senator **Warner**. Thank you. Mr. Hart.

Senator **Hart**. Dr. Ikle, can you envision a time in a decade or two when the political climate of this country is such, that we had spent $25 or $30 billion of research and development of a fairly vast array of new technologies to defend ourselves when people, particularly those who are advocating this program, will genuinely be willing to see some future administration in 1995 or 1998 or 2002 virtually give that technology away to the Russians?

Dr. **Ikle**. Senator, the context in which a sharing of the technology has been discussed by the President is in the context of reductions in offensive forces which, of course, would immensely facilitate the job that General Abrahamson and his team is trying to grapple with. And in that context, where we have an agreed transition, where we have sharp, definitive reductions in offensive forces, it could become part of this phasing, that you talk more and more about the defensive technology and make sure that it serves defensive purposes.

You are quite right in your skepticism: as long as there are no reductions in offensive forces, no agreement on the transition, it would not seem plausible that such sharing could take place.

Senator HART. Well, so-called liberals in arms control are so often criticized by their political opponents for being naive and unrealistic about Soviet intentions; what boggles my mind is a complete flip-flop where those who have made careers out of being skeptical of Soviet intentions and good will are going to be willing to sit down at a table and lay out the results of General Abrahamson's vastly expensive and highly technical and highly sophisticated technology to the Russians. I just frankly cannot ever see that day happening politically, and as far into the future as I can see. And so this talk about orderly transition and shared technology I think is politically naive. But apparently we disagree.

General Abrahamson, on this chart comparing the Manhattan project and the Apollo project with SDI, those figures for Manhattan and Apollo projects include construction and infrastructure and acquisition of hardware and a lot of things we are not talking about in SDI, do they not?

General ABRAHAMSON. In the early years they did not—it took time to begin to develop and get the concepts. So I think that the early years are in fact an appropriate comparison about the ability of projects that have many, many facets to them to begin to go out and handle different projects to achieve an overall objective. It is correct that there are some of those that did say it was an investigation of how could you build a launching platform, and that kind of thing, but in the early years I think it is a fair comparison.

Senator HART. So maybe 1943, on the Manhattan project, 1943 through 1944 is analogous, and 1960 through 1962 is analogous, but you begin to get into the soaring bars toward the end of that spectrum, 1945 for the Manhattan project and 1963 for Apollo, you are talking about buying a lot of hardware there, and that is not just research dollars, is that right?

General ABRAHAMSON. There is in fact a fair amount of hardware and things that have to be bought as part of this research program as well, and frankly, I am not so familiar with those projects that I would split it exactly as you have indicated there.

But nonetheless, I think that the first several years and the fact that a research program can productively and prudently spend money toward an objective at rates that are much higher than you normally see in our military development programs, where we are restricted usually by a single prime contractor or one or two prime contractors, and then they are supported by a vertical structure, I think that is the difference between the buildup rates in this program and the buildup rates that are often referred to, for example, when Dr. Schlesinger talked about 30 percent as a good factor.

I believe that that is a good factor for development programs where it is a more vertical structure.

Senator HART. Do either of you believe that it is possible to develop, to prove the feasibility of space-based defenses without field testing as prohibited by the ABM Treaty?

Dr. IKLE. It is a matter of the degree with which you can convince yourself, convince Congress of what is feasible. We do in many areas a scaling down of tests from the real life size to smaller sizes or smaller yields or what have you and rely on those. But the more you can simulate the real situation, the more convincing, of course, the tests can be.

General Abrahamson can certainly say more about this than I could.

General ABRAHAMSON. Perhaps what you are really getting at, Senator, is what the character of the decision that this Congress or a future Congress and a future administration may well be faced with. It will be a very complex technical decision, and I think that really needs to be underscored. Perhaps the best example of it was the complex decision that NASA and this Nation faced when they launched the first space shuttle. Prior to that time all of our manned systems had always had an unmanned, full-up test. However, the space shuttle was not designed so that it could work that way, and the people who directed and carried out that program had a very difficult choice, to be able to understand, first of all, and to have the confidence that, for example, their software that was developed for that system and tested in separate simulators, that the engines that were only tested on the ground and were never tested at altitude would work and work effectively; that the aerodynamics of that system, which was done on a scale model basis in wind tunnels; that the sum of all of that added up to the confidence to go ahead. That kind of equivalent situation is what your colleagues in the future may well be faced with.

It will be a very difficult test, but nonetheless, our technical community with our advanced simulation capabilities and our ability to reach across and to try to integrate all of that knowledge, were willing to launch the first space shuttle with two men in it, and it was successful, and it has continued to be successful. And I believe that that is the situation that we are talking about.

Senator WARNER. Thank you, Mr. Hart.

Mr. Goldwater.

Senator GOLDWATER. Maybe it is a good thing in this country that we have people who are always opposing. We have people that say we can do things, and we have people that say you cannot do things. I guess that will work out well in the long run, but I referred earlier to a headline in the morning paper about computers, and the fact that the computers could not keep up with the work that was needed on SDI.

I would just like to read part of a letter that Chairman Warner received this morning from Dr. John McCarthy, professor of the department of computer sciences at Stanford. He said, and I quote:

> There have recently been claims by various scientists that the computer programs needed to realize the Strategic Defense Initiative are impossible to make reliable and therefore the project must be abandoned. As far as I can see, these scientists are speaking beyond their competence in order to lend support to the anti-SDI cause. The computing arguments raised by the scientists opposed to SDI are of a general character. The Fletcher Report on Ballistic Missile Defense says a program with 6 to 10 million instructions will be required. This is a very long program. It is

asserted by these scientists that the program cannot be written, and if it were written, it could not be checked. However, the program put into use by AT&T when the Nation changed over to electronic switching has 50 million lines of code. Furthermore, it has 14,000 interconnections between nodes compared to an estimated 4,500 interconnections in the SDI program. In other words, the telephone program is more complex than SDI requirements, as well as being longer, and yet the program worked well from the moment it was put into operation.

That is just part of the letter, and if the chairman has no objections, I would like to suggest that this might be put in the record.

Senator **Warner**. No objections.

[The information follows:]

Stanford University,
Department of Computer Science,
Stanford, CA, September 5, 1985.

Hon. John W. Warner,
U.S. Senate, Russell Senate Office Building, Washington, DC.

Dear Senator Warner: There have recently been claims by various scientists that the computer programs needed to realize the Strategic Defense Initiative [SDI] are impossible to make reliable, and therefore the project must be abandoned. As far as I can see, these scientists are speaking beyond their competence in order to lend support to the anti-SDI cause.

The computing arguments raised by the scientists opposed to SDI are of a general character. The Fletcher report on ballistic missiles defense says a program with 6 to 10 million instructions will be required.[1] This is a very long program. It is asserted by these scientists that the program cannot be written, and if it were written it could not be checked.

However, the program put into use by AT&T when the nation changed over to electronic switching has 50 million lines of code. Furthermore, it has 14,000 interconnections between nodes, compared to an estimated 4500 interconnections in the SDI program.

In other words, the telephone program is more complex than SDI requirements, as well as being longer. Yet the program worked well from the moment it was put into operation.

The argument against SDI continues by asserting that the only way to make the program reliable is to have a nuclear war in order to test all parts of it. This is a mistake. Many present programs are designed to deal with emergencies too dangerous or expensive to allow them to happen for test purposes. Yet techniques are available to make these programs reliable. The mammoth AT&T program worked when it was turned on although it had never been tested in "battle".

These techniques for checking large programs include the following. First mathematical techniques exist for proving parts of a program correct and checking those proofs by computer. Second, simulated battle conditions can be created that are even more complex and more stressing than a real attack. For example, the test can throw more missiles, warheads and decoys at the defense than the Soviets could ever build. And it could launch them more quickly than could ever be achieved in an operational environment.

My conclusion, based on 35 years of research in computing and AI, is that those who oppose Strategic Defense or "Star Wars" have no basis in computer science for predicting its failure. They must rely on the general principle, "Where there is a will to fail, obstacles can always be found."

Sincerely,

John McCarthy.

Senator **Goldwater**. I am constantly amazed at the science of computers. I think there are something like 2 billion nodules in the brain. Am I about right on that?

Senator **Hart**. It depends upon whose brain. [Laughter.]

Senator **Goldwater**. Well, I am not comparing mine to yours. [Laughter.]

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[1] Report of the Study on Eliminating the Threat Posed by Nuclear Ballistic Missiles, Volume 5 (Battle Management, Communications and Data Processing), p. 43.

But I have seen the computers advance to the stage where it can now talk to me, it can talk to anybody. Scientists say that the computer can never think, and yet if we can put enough of these so-called nodules into electronic form into a computer, who can say that someday they cannot think? And I hate to think that might happen. Who knows? We might wind up with a Congress full of computers.

I merely mention these things here to you two gentlemen because of your long association. Do you look upon the computer problem as essentially a problem that you cannot overcome in the SDI Program?

General **Abrahamson**. Absolutely not, sir. It is a difficult problem. I have often said in testimony and in other audiences that I believe that it is probably the long pole in the tent, meaning that there is a great deal of work that needs to be done. But to conclude that it is impossible that I think I have to wonder just why it is that certain individuals are making those kinds of claims. I absolutely do not accept that.

Senator **Goldwater**. Do you agree with that, Doctor?

Dr. **Ikle**. Yes, certainly.

Senator **Goldwater**. Just one more comment, and I know John Glenn over here will understand what I am talking about because we are both pilots, and I know that Abe is.

I was flying a Gulfstream down to Savannah the other day, and they have a very new inertial guidance system, highly sophisticated, and it will take you anyplace in the world if you know the three-letter identification. Well, I just happened to remember Singapore, why I do not know, so I punched in Singapore and the answer came out 19 hours and 20 minutes, and then it flashed red, meaning you cannot do it. But that is the kind of things that we are doing now with just plain black boxes. We are doing them every day by just ordinary citizens like myself who have a hard time getting two and two to come out four every time.

Mr. Chairman, I have no other comments.

Senator **Warner**. Mr. Chairman, we will admit to the record this letter, and we thank you for your participation.

Mr. Exon?

Senator **Exon**. Mr. Chairman, thank you very much, and welcome, gentlemen.

As you know, this Senator has supported research on strategic defense both as a counter to Soviet efforts in the areas of strategic defense and offense but also because I think that SDI is the only real reason that the Soviets are back to the bargaining table in Geneva. I think our continued research on SDI is tremendously important, and I will continue to back it in a reasonable fashion.

But let's think ahead just a little bit. Dr. Ikle, do you agree with the President's oft-stated position that notwithstanding any other possible agreements with the Soviet Union, that we will hold to our position of proceeding full speed ahead with the SDI?

Dr. **Ikle**. Senator, I certainly agree with the President's emphasis on continuing with this very promising program. I do not think the President has said full speed ahead. I think the President has said we want to discuss with the Soviets, as I mentioned earlier, the transition phasing of defenses. We are not looking for superiority. So we would prefer a cooperative approach.

Senator **Exon**. We are not looking for superiority?

Dr. **Ikle**. We are not looking for strategic superiority by means of the Strategic Defense Initiative. Let me be more precise.

Senator **Exon**. Well, would not the deployment of the SDI Program develop the way it has been sold, give us superiority? There is not any question about that, is there?

Dr. **Ikle**. Our objective in pursuing the strategic defense initiative is not to achieve strategic superiority over the Soviet Union. We want to make it part of a long-term-arms-reduction process, reductions in offensive forces, a cooperative, if possible, phasing of the defenses, and we of course are also aware that the Soviet Union has done a great deal of work in the defensive area, so it is unlikely that they would not move ahead on their own on continuing what they have been doing. They are in fact continuing to do work on defenses.

Senator **Exon**. General, could you answer that question, or is that not in your bailiwick?

General **Abrahamson**. In terms of the superiority question? Let me make sure that I understand which of the questions you asked you would like me to answer.

Senator **Exon**. Either one or both.

General **Abrahamson**. I believe that as my testimony indicated that what we are after, the real objective of this program is improved security for the United States and the allies, and all of us on this planet, and in that respect, we would like this system to be useful now in arms control negotiations, inductive to an environment that might help produce reductions.

However, if those reductions do not occur, we have to have technology that we are researching that will be robust enough that we can counter whatever the Soviets may choose to do because otherwise we would give them a veto over our ability to find a way to achieve that safer world. Therefore, those are extremely important goals for the technical research program.

Senator **Exon**. Well, then, what you are saying, General, is that if this system is developed as per your goal, that it would be the ultimate weapon that mankind has searched for from the beginning of history? Does that mean that if SDI is successful, the Soviets would not develop something similar to it and that we could end the arms race?

SDI is not the ultimate weapon, is it, defensive or otherwise?

General **Abrahamson**. Sir, there is no such thing as the ultimate weapon, obviously. What it is is first of all a different strategy, a strategy that we believe can offer a great deal more security, stability in crisis, and security and safety for all of us, and in order to conduct that strategy, you have to have technical means. And the research program is to really see if the technical means are feasible. But there is no ultimate weapon.

On the other hand, I would like to point out that there are weapons that have been made impotent and obsolete. I have often made the point that you do not see much cavalry around anymore, and at the turn of the century the cavalry was a very important part of every army. But the development of the machinegun and other advanced technologies did indeed make those technologies obsolete, and in fact, the reaction of many of the nations that had cavalries when they really saw and understood what some of the advances of technology could produce, was not to buy more cavalry or more horses.

Senator EXON. General, my time is up.

I would simply say I am not the military expert that you are, but while we do not have cavalry anymore, we do have a tank corps, though, do we not?

General ABRAHAMSON. Yes, sir.

Senator EXON. Is there a significant difference in the mission of the two?

General ABRAHAMSON. No, there is not a significant difference in the mission. On the other hand, there is a different kind of weapon, and if we can find one that is more stabilizing, and that is why we are really aiming at the nuclear ballistic missiles.

Senator EXON. Thank you. My time is up, Mr. Chairman.

Senator WARNER. Thank you.

Senator Quayle.

Senator QUAYLE. Thank you, Mr. Chairman.

Gentlemen, one of the things that I would like to focus on for a moment is on the potential for an ATBM. I briefly read through both of your statements. I am sorry I was not here to hear them, but I find that basically no mention in Dr. Ikle's statement and very little mention in General Abrahamson's statement about the potential of ATBM.

It seems to me that if in fact we want to get to an early deployment of some technology related to SDI capabilities, that one of the areas where we might want to deploy and not just research, test and develop SDI technology, would be with our NATO allies. Certainly an ATBM would be consistent with the ABM Treaty and I would think that our allies would be most interested in this defense against the Soviet theater and tactical missiles. The Soviets now have some new short-range intermediate ballistic missiles, the SS-21, the SS-22, and SS-23, having both conventional and chemical capability.

I wonder, Dr. Ikle, is your silence just a slight omission? Are we not pursuing the possibility of what we can do in ATBM, or am I misreading your statement?

Dr. IKLE. Senator, I agree with you, and we are pursuing in discussions with our allies their interest, their attitudes, the possibilities for antitheater ballistic missile defenses. You are absolutely correct, such defenses, as they become technically effective, could contribute a great deal to the security of our allies.

We have pointed out on several occasions, I know Secretary Weinberger in several speeches has pointed out that the allies or the defense of NATO are threatened not only by the nuclear-armed Soviet shorter range missiles, but in the 1990's, by conventionally-armed missiles because of the high accuracy. That threat of conventionally-armed Soviet missiles that could knock out much of the NATO military structure in one surprise attack is taken very seriously by our allies because it means a threat below the nuclear threshold for which the Soviets would exploit the capabilities of unopposed ballistic missiles.

Therefore, we are discussing with several allies how we might oppose that kind of attack and eventually could have an effect against such arms.

Senator QUAYLE. In other words, you are saying that there is a potential for ATBM?

Dr. IKLE. Yes; there is.

Senator QUAYLE. I do not want to get into this too much now because I think this committee is going to hold a hearing on this subject later on.

General Abrahamson, what kind of a resource allocation are we possibly making to the ATBM area? Are you moving in that direction? That was not on your priority list. You did briefly refer to it.

General ABRAHAMSON. It is in the priority list, and we consider it to be very vital. We think that our direction from the President is quite clear, to research the technologies that would apply to ballistic missiles of all ranges for the defense of our allies and ourselves. We included in our architecture studies an examination of some of the ways in which our existing technologies might be applied to those problems, what we might have to do differently to work on that problem, and we are carrying out some research programs that are exclusively aimed at systems such as that. The short range HIT missile is an example of one of those research programs that we would probably not use as an underlayer in the United States but could be an effective layer in Europe.

I would also have to add however, sir, that the full range of opportunities here has not been as fully explored in that technology area. That is an additional reason why we are interested in our allies participation and advice, as well as working with us in these areas.

Senator QUAYLE. Well, I look forward to getting some more information in detail, and I think the chairman is going to schedule some additional hearings that we can have to look at the specifics on the ATBM.

I have another question for both of you. Let's say that the Congress in its deliberations decides to reduce the SDI budget. SDI will be a target for a lot of the critics, whether it is going to work. Many people just do not want to have missile defenses. Let's say Congress begins to hatchet SDI down. Now, then, I wonder if one of the options that you might not want to consider if the Congress responds in this way is to shorten your agenda, to go to systems that you could test, develop and deploy much earlier than what you are planning to do now?

And the reason I bring this up is because if, in fact, Congress cuts back the program, then I think it is probably very incumbent upon us to move with near term technology to overcome that criticism. So therefore, would you have to consider, to move all these things up to convince the skeptics that SDI will really work?

Dr. IKLE. Senator, that is perhaps a political question that we should ask you rather than you should ask us. It is really a question as to how the decision can be——

Senator QUAYLE. Well, let's say the Congress moves in that direction. Let's just take that political assumption that the Congress may move in the direction of not giving you your full budget on SDI and they will cut it back a lot more than you had anticipated.

Would you not then have to sit there and reconsider what you are doing and would one of the alternatives not be to say, OK, we are going to have to take what we can do best in the near term to show everybody that we can do that, which means earlier testing, earlier development and earlier deployment?

Dr. IKLE. I think if that should happen, the administration may want to consult with Congress and find out whether it is the sense of Congress that they would rather have some early experiments, maybe riskier, maybe more limited, so that they can then make their further decision, should we turn to more adequate funding, or whether they want to string this out and of course risk that the Soviet Union, with its own program, will go ahead and overtake us in the next decade.

So I think that is, in part, a political question and in part there are technical aspects, General, that you may want to address.

General ABRAHAMSON. Without addressing the political objective question which I think would need to be a consultive thing between the administration and the Congress, the technically responsible way to proceed is indeed what we are doing. The wrong thing is to try to maintain this whole broad front of technology and carry it through and not make choices.

Senator QUAYLE. But if the Congress does not give you the opportunity to do that, then you are going to have to make some earlier choices, some earlier decisions, and I would think that we would probably have earlier testing, earlier development, and earlier deployment of these systems.

General ABRAHAMSON. We are making earlier choices now and making earlier choices between the technologies as a result of two things, both the new opportunities that are developing based upon the speed of the research, and second, based upon the fact that we are cut back and therefore cannot proceed in the broad way that we had to.

Senator WARNER. I am going to have to ask the Senator and the witnesses to stay within the 5-minute rule.

Senator Wilson? And then I will invite our two members of the full committee to join us.

Senator WILSON. Thank you, Mr. Chairman.

I think the point has been made with painful clarity in the testimony of General Abrahamson this morning that what Senator Quayle fears, Congress has already done. I quote:

> At the current authorization level, the program has been severely affected and considerable changes have been forced. The result has been that the program has had to make premature down selection of certain key technologies. This will significantly increase program risk, cause program slippage, delay completion and increase total cost. For example, reduction in the number of contractors in any individual project will decrease competition and reduce program scope. These reductions have left the program at a minimum level to study the complete requirements of the strategic defense program.

Mr. Chairman, I cannot ignore that statement. It occurs in the midst of the General's testimony. He said a number of other important things, none in my judgment more important than that. I mean, that is a very stark statement that we have caused program slippage, increased total cost, and mostly that because of the fact that Congress has underfunded this, we have had to make premature down selection of certain key technologies.

Now, Mr. Chairman, I think that that is an indictment of Congress, and I hope that we will remedy that.

Let me ask you, General Abrahamson, could you comment in terms of both policy and technology how would you respond to those who are sharp critics of the SDI and who argue that it is a dangerous gambit for us to pursue the program because if you make the assumption that both sides have only a 60-percent effective defensive system, that the one who thereby employs a first strike is in a position, having not decimated but done some damage to the retaliatory capability of the opponent, to then present against what is left in the way of a retaliatory force something in the nature of a 99 percent effective defense?

General ABRAHAMSON. Obviously it is an area of concern, and it deals with this transition period and how one begins to build in a stable and in a nonthreatening way from where we are today with no defense on our side—certainly the Soviets do have some defense—and furthermore, have the potential of expanding that defense very, very dramatically in a much shorter period of time than we can because of what they have already done in their more conventional ballistic missile defense program, the one that they have maintained over now nearly two decades.

But to go to your fundamental question, the key is to carefully draw down your offensive systems as you are building up your defensive systems, and not to have the kind of defensive systems that invite attack. We have been conducting simulations, war games of the problems, and both you and Senator Quayle have participated in one type of those games. But we have gone further than that into the actual battle conduct to examine those kinds of questions, and what we find in general is that with the layered defense, one that denies the enemy the opportunity of assuring that he knows which warheads that he has targeted will be the ones that get through to specific targets, that you begin even with a partially effective defense to make the first strike more and more doubtful, and in fact, as you make it more and more doubtful, you already increase what we are aiming for here, and that is stability in a crisis.

That is why we think defensive deterrence has a very rightful and proper place in our arsenal even before you achieve a fully effective defense.

So I think that the construction that some of our critics lay out, while it is a valid concern, is one that has not thought through the full depths of the way a real attack is put together.

Dr. Ikle, do you have anything to add?

Dr. IKLE. No, I think that is enough.

Senator WILSON. Dr. Ikle, in view of the fact that the United States early warning radar sites at Thule in Greenland and Fylingdales, England, are specifically permitted by the ABM Treaty, including even upgrades to those sites, and in view of the fact that the Krasnoyarsk battle management radar in Siberia is an unambiguous violation of the ABM Treaty—I am leading the witness slightly—how would you comment on the recent Soviet proposal to somehow exchange these systems as though that would be an equivalent bargain?

Dr. IKLE. Well, it is clearly an attempt, as your question indicates, to confound public opinion among people who do not understand the real situation, to offer to stop what is a clear violation of the treaty in exchange for a program that we have ongoing, fully permitted under the treaty, and that is a modernization of radars which, of course, existed well prior to the ABM Treaty.

What I hear from the discussions in Europe and so on is that the experts there certainly understand that this is not an acceptable exchange and that it was devised to confound popular opinion.

Senator WILSON. Thank you, Mr. Chairman.

Senator WARNER. Mr. Bingaman.

Senator BINGAMAN. Mr. Chairman, thank you for letting me participate here.

Let me just ask, General, you do specify on page 5 that you have had to prematurely downselect certain key technologies.

Could you specify to us which ones?

General ABRAHAMSON. There are many, many areas, but let me give you some examples. In the directed energy area, at the time of the Fletcher Commission there were some of the best of our directed energy experts that laid out a plan, and we expanded on that plan and presented that plan to the Congress, and made it available to the committee as one of the first acts after I took over in April 1984. That included different space-based as well as different ground-based laser technologies, and there is promise and there are advantages in either and all of these types of systems.

One of the types that we have regrettably had to delay in a very significant way is work on the space-based laser concept, and that is one example. In other areas we have cut back in spite of some of the progress. In the kinetic energy guns or rail guns, those kinds of systems, I have cut back that technology. Those are just some examples. Actually it goes further in many ways. I have delayed parts of the terminal imaging radar program that is very fundamental to a terminal defense. I have underfunded two of our satellite surveillance programs that have a requirement not only for SDI but also an operational requirement other than the SDI. So those are some examples.

Senator BINGAMAN. Could we perhaps get a complete list of what you identify as key technologies that you have had to downselect so that we could have that for the purposes of the record?

General ABRAHAMSON. I will provide that for the record.

[The information follows:]

PREMATURE DOWN-SELECTION OF KEY TECHNOLOGIES DUE TO BUDGETS CUTS

As appropriations hearings for this year's budget have not been completed, we can only provide a partial listing, not a final determination, of all the key technologies that have been or will be down-selected due to funding cutbacks. Substantial reductions in SDI research monies has affected every directorate in the Organization. Thus far, major reductions in each department's budget have severely impacted on the performance of the SDI proram. Specific examples are given below.

SURVEILLANCE, ACQUISITION, TRAINING AND KILL ASSESSMENT [SATKA]

Significant reductions will be made in programs to develop sensors which collect signature data on Soviet ICBM's and RV's. Absence of this data will impact on ability to develop sensors that must discriminate RV's from decoys.

Imaging lasers being developed to aid in discrimination will drop one promising technical approach (short wavelength IR systems), greatly increasing project risk.

Premature downselect may force many programs to rely on a single contractor.

The Space Surveillance and Tracking System [SSTS] program will be reduced in scope, addressing only a few of the most critical issues—greatly increasing program risk.

Radiation hardened signal processing efforts will be reduced almost in half, increasing the risk of achieving high performance computers capable of surviving in a nuclear environment.

Infrared focal plane efforts will be cut in half which increases the risk of producing sufficient chips for performance evaluation.

DIRECTED ENERGY WEAPONS [DEW]

Reduce previously planned major experiments.

High power hydrogen fluoride integration reduced to a minor planning level.

Restructure/reduce previously planned major experiments.

GBL Integrated Technology Uplink Experiment [ITUE] terminated in favor of FEL/GBL. Technology Integration Experiment Excimer ITUE reduced to a minor planning level.

Major Neutral Particle Beam [NPB] Space experiment down-selected.

Alpha/Lode/Lamp slipped by one year.

Excimer laser technology severely reduced, both single pulse and repetitively pulsed. Excimer Midpower Raman Shifted Laser Device [EMRLD] (repetitively pulsed) program has been substantially curtailed and its programmatic effort restructured to support revised SDI technology goals.

Radio Frequency Linear Accelerator [RF LINAC] laser technology severely reduced to provide backup technology effort to the induction LINAC. Program has been reoriented to support space-based approach to FELs.

Atmospheric compensation—Generic technology for supporting atmospheric compensation has been severely curtailed.

Accelerator test stand upgrade [ATSU] delayed one year.

KINETIC ENERGY WEAPONS [KEW]

Exo-atmospheric interceptor development [ERIS]

Program is now technology oriented only, with no parallel analysis to insure the ERIS technologies reflect the requirement of SDI System Architectures as they evolve. Integration of related technologies into single interceptor will not be possible. Brassboard and subassemblies for booster, kill mechanism, warhead, and supporting test hardward will not be developed.

Fifty percent reduction in amount of contractor work to investigate innovative cost reductions. Includes loss of early shuttle flight to look at effect of thrusters on optical components.

Endo-atmospheric interceptor development [HEDI]

In-house verification tests of seekers, coolers, and other critical components of HEDI eliminated. Total contractor effort now.

Rail gun

Most programs downscoped. Advanced gun design studies reduced from four to two, integrated projectile fire control and guidance tech development reduced from five to three contracts. New starts in nonrelated advanced minimum technology threshold.

Kew technology programs

Army Technology program executed at a higher risk level and with reduced ability to introduce advanced technology into interceptor demonstrations planned for early 1990's.

Emphasis of Army program now centered on miniature gyro and accelerator development but with a six month program stretch expected. Contracts on micro-chip development, hollow nose cone projectile development, advanced Multiple Kill Vehicle [MV] work, boron, conversion and high burn rate liner development will all be canceled.

Air Force Rocket Propulsion Laboratory [AFRPL] study contracts to be delayed approximately six months. Ability to use rocket technology spin outs in the Space-based Kinetic Kill Vehicle [SBKKV] demo has been jeopardized. All divert propulsion efforts stopped axial propulsion work reduced to laboratory level research only.

Air Force contractors selected to develop fire control and guidance technology cut from three to one.

SYSTEMS ANALYSIS/BATTLE MANAGEMENT [SABM]

Technology development efforts on battle management computing hardward and software will be delayed.

Design and development of portions of a National test bed for strategic defense technology validation experiments will be delayed by up to one year.

SURVIVABILITY, LETHALITY AND KEY TECHNOLOGIES [SKLT]

Survivability

One-year delay in implementing counter measures [CM] programs against NPB and High Power Microwave [HPM] threats.

Additional cuts will cancel counter measures [CM] against x ray and GBL threats.

Lethality

Planned procurement of hypervelocity (10 km/sec) test facility cancelled-delaying final lethality assessments.

Space power

Concept definition and technology developments needed to support subsystem development for DEW and KEW system delayed one year.

Space logistics

No meaningful investments can be initiated in technologies needed to reduce launch costs.

Senator BINGAMAN. On page 12 of your testimony you indicate we will judge defenses to be desirable only if they are survivable. This is sort of a conceptual problem, but I think several others have raised it, and I would just be interested in your answer. Once again, it strikes me that in developing these long range directed energy or kinetic energy space-based weapons to hit missiles in boost phase, for example, inherent in the development of that is the development of the technology that makes those space-based assets nonsurvivable, and I would be interested in knowing how you fix that problem.

General ABRAHAMSON. The chairman invited me in the classified session to answer some of the questions that I cannot answer in the open testimony, and I would like to use that opportunity to give you much more specific answers for some of those particular questions.

Let me just say that we are looking for where the fundamental advantage lies, the physics of the situation, the engineering advantage that goes with being in space and/or the timing advantage. That is something that we can exploit so that we would not proceed with systems that are indeed limited and nonsurvivable, and unfortunately, I would have to do that in a classified session. I must respond there.

Senator BINGAMAN. That is fine.

Let me also ask if you could respond here in the open session to the rest of that statement on page 12, that is, that you also judge defenses to be desirable only if cost effective at the margin.

Could you just define that phrase "cost effective at the margin" as you are using it?

General ABRAHAMSON. It is a difficult area to implement but it means that we feel that, as we project ahead to a point in time to where you have a partial system and you are beginning to build forward, you continue to build up that capability because it will not happen just all of a sudden at one point in time. We must ensure that the kind of defenses that we have chosen, and the systems that we have chosen to be part of the defenses, would be the kind that would discourage the Soviets from wanting to build more missiles or from undertaking a course that would force us into a very expensive reaction. It must be cost-imposing on the Soviets.

Now, it must be understood that this is not just a simple dollar/missile or ruble exchange of the kind that has often been talked about or looked at. We are examining and laying out the fundamental assets of the Soviet Union, what their production base is, and the development of their missile program, and looking for the kinds of characteristics of our system that would be most expensive for them and most difficult for them to overcome, so that what we are really after is behavior modification.

Senator BINGAMAN. So when you say that our systems are only desirable if they are cost effective at the margin, you mean if they impose a cost on the Soviets which is greater than the cost that we are incurring in putting in the system? Is that what you are saying?

General ABRAHAMSON. If they do not take the course of action that we want, and the course of action that we want is for them to begin to recognize that their ballistic missiles do not have the same omnipotent military value that they had in the past, and therefore see that the proper and reasonable course for them to do or to follow is to shift to their own defenses as opposed to continuing to try to build up offensive weapons.

Dr. IKLE. To put it differently, Senator, the idea is it should not be easy for the Soviets to countermeasure cheaply our defenses and to negate them with a very small effort that would cost us a great deal to overcome again.

But let me also add, incidentally, that this is not unique for strategic defense. That is a requirement that we have emphasized across the board. As we are forced to compete with the Soviet Union, we want to develop those things which are not easily countermeasured by them, whether it is antitank weapons or whether it is offensive weapons or what have you.

Senator WARNER. Gentlemen, the rollcall is in progress.

The Chair recommends that we now recess the hearing until 11 o'clock sharp, allowing members to vote and return, and then we will lead off with either Mr. Levin or Mr. Glenn.

[A recess was taken.]

Senator WARNER. The subcommittee will resume, and we will open for questions from Mr. Glenn, and thereafter, from Mr. Levin.

The Chair will then ask the witnesses to present some direct testimony relating to the computer technology and most specifically, the software.

Senator Glenn, would you lead off?

Senator GLENN. Thank you, Mr. Chairman. I appreciate the opportunity even though I am not technically a member of the subcommittee——

Senator WARNER. Well, few members of the committee have put more time on this subject, so we welcome you.

Senator GLENN. Thank you.

I am still confused about administration policy on sharing information, and I know we say, well, we may negotiate or something. The President started out with a very positive statement on this, but I do not quite understand it. I am not sure that, for instance, if we make a new breakthrough in tank armor and there is no known projectile that will get through it, will we share that with the Soviets, because that is strictly defensive.

I spent my life flying fighters; General Abrahamson did so much of his life also, and fighters are defensive.

Now, why do we not share technical information on the F-15 and our superiority in fighters? That is defensive. I do not understand this really and how about the Stealth technology? If it is going to make things more reliable, that is defensive. That is a passive type thing, granted, and it can be used on fighters. So if that makes them less invulnerable and it is strictly defensive, why do we not share that with the Soviets then?

Here we are coming up with new technology in other fields all the time, and we want more R&D on these things so we maintain superiority, and yet we get to SDI, it may not be the ultimate defense aid, but it is a big one. And then we say, oh, now we are going to share it with the Soviets. I find nothing that has boggled the minds more back in the great and sovereign State of Ohio, I can guarantee you, than this proposal that we are going to spend hundreds of billions of dollars, perhaps, for a system and then turn right around and give it to the Soviets and say, now, you build the same thing now that we have developed it.

So is it the administration policy to share this information or is it not?

Dr. IKLE. You are quite right, Senator, the question of sharing has been put in various flamboyant contexts and appeared rather puzzling to many people. The President, I recall, was asked about it nearly a year ago on television, and he said if the Soviets agreed to get rid of the offensive arms, we could then work together and yes, share this technology to have residual defenses. You would only need small defenses at that stage to protect against cheating and possibly third powers that are not participating in this arrangement.

Senator Hart quite rightly wondered was it not politically naive to expect the Soviets to cooperate with us in an agreed transition, trimming down massively the offensive forces and then leading to a point where we can safely work together as we work together in the International Atomic Energy Agency, for example, to have technology that protects us all.

I think it is a good and important question. Is this not politically naive? I think in the short term, the hardball view may well be that we cannot get such a transition, but then let me add, Senator, as a personal view, I think it is even much less likely that in the short term we could get or even in the long term we could get agreement on maintaining this mutual balance of terror in a stable fashion.

In a way, what we are proposing here by eventually working together with the Soviets, if they are willing, is something that is more plausible or, let me say, less implausible than what other people propose who say we should maintain the arrangement we envisaged in 1972 but which we have learned over the last 15 years did not work, namely, that we have stability by abolishing defenses and thereby can reduce offensive arms.

We think that is contrary to all the Soviet instincts.

Senator GLENN. How about in all these other fields, then, if we have good advanced tank armor or defensive fighters, do you think we should share them with the Soviets?

Dr. IKLE. I do not see this at this time even crossing our mind. We try our level best to protect sensitive technology in these areas as well as in the SDI area.

Senator GLENN. Well, I will not pursue that any further except for one other question here: have you had any discussions in the administration about any limitations on SDI that might be negotiable items to be put on the table at Geneva?

Dr. IKLE. Well, I do not want to comment upon preparations, certainly not in this open session, Senator, for Geneva. By saying that, I do not want to imply that my answer to your question would be yes, nor do I want to say it was no.

Senator GLENN. OK.

A year ago this past summer I took a Senate group which included staff people from leading committees and went around the country for 10 days talking to our leading laser and directed energy research people at our major labs. I repeated the same thing this past summer, and so I think I come into some of these next questions here with recent information and a technology background perhaps that is valuable in this discussion. I would say one thing first. I would disagree with General Abrahamson that SDI is like Apollo, and I have always disagreed with making that analogy. I have taken exception to it in the past because we did not need to make one single research breakthrough to go ahead with Apollo. There was not one single scientific thing we needed to know except just do an awful lot of hard engineering spadework in putting all of these chunks and pieces together, and we knew every single scientific fact to do that. We did not need any research programs other than engineering research, and the production research and things like that that were comparatively easy.

So I disagree with the analogy, but the question then is, as we have little breakthroughs in SDI research one place or another, and as we come up to these decision times that you will have to share with us because we are going to have to vote the money for this program and we are going to have to understand it, there will be certain breakthroughs and there will be a tendency to want to deploy parts of the system. Terminal defense, it looks like there may be some things there. We talked to folks on this trip. I will not get into the details, but terminal defense looks like there may be some reasonable, good things cooking there.

Would we deploy that part of the system, or is there a certain threshold level that we have to get up to in capability before we go ahead with any of the system?

Now, that is something that is sort of a wide open question, but I think it is going to be crucial for us. As we find in your statement, you have some things here where we are making progress in these areas. Well, we are going to latch onto those one of these days and say, oh, boy, here is one that is good; we had better fund that and go with it right now, and there is going to be a tendency to do that.

What is our threshold before we do that, and are there parts of this whole system that are absolutely vital, or we do not go with any of it?

General **Abrahamson**. Sir, you and I have had separate discussions on this, and I believe it is imperative that we gain the benefits of a layered defense, and that means that several layers. The best possible way and most stable way to proceed is to be able to introduce more than one layer at a time, and the layer that has the greatest leverage is the boost phase layer. So therefore, I believe that we need to have some capability in the boost phase.

Now, you may well at the same time then try to bring in a terminal or some other systems that go with it, but I personally believe that that boost phase layer is very, very critical.

Senator **Glenn**. That is probably the toughest part to do, too, is it not?

General **Abrahamson**. I believe that it has many very difficult elements, but I am not sure that it has to be a terribly long way away in terms of some initial capability against the kinds of threats that we may face now or in the very near future.

Now, when we look to their responsive threats, the things that they could do even beyond that to make it more difficult, then we always have to be in a position to grow the technology so that we can handle those as well.

Senator **Glenn**. Do you see that as being important enough, the boost phase and the layered defense—the boost phase being a part of the layered defense, that unless we have a capability in the boost phase you would not go ahead with any of the system?

General **Abrahamson**. Well, there is only one proviso I would add to that. That would be my recommendation, if there were not some overriding external situation. If there were such a thing as a Soviet breakout of the ABM Treaty or something of that kind that may add a military or political necessity for a completely different character to the program, surely that may change the situation.

Senator **Glenn**. Another thing on our financial considerations here, we are in economic straits, as everyone is well aware. We might make this research and see that if we could put, let's say, $1 trillion into a certain part of it, just to make an example here, and I do not mean that that is a cost estimate or anything, but let's say $1 trillion, but we cannot afford that, have you run out any approximate costs of any of these things now? Are we far enough along in the research, and are you comfortable enough with some of the research that you could begin to say, well, given the historical record of advances in a breakthrough like this, we can see that it is going to cost 20 times whatever it is? Can you make cost estimates of the whole system now as you see it?

General **Abrahamson**. We are not making absolute cost estimates on systems. I think that the important thing and the thrust of our system analysis studies have been to make cost comparisons.

I think that those are valid at this point, and they direct us for the ones that can indeed offer lower cost solutions for the kinds of technologies that may be ready early and others may be ready late. So we do have at this point cost comparisons. We do not—and I have resisted because I do not believe that we are far enough along that I can offer a responsible, overall, absolute cost estimate for those systems.

Senator GLENN. One other question, and I know my time is up, Mr. Chairman. One other question, if I might, and that is we see this cartoon on TV where the drawing comes on and the nuclear weapons are bouncing off of it and bouncing away, and it is 100 percent, and that is pretty nice. Would that we could live in the cartoon world part of the time, I guess, but we know that in the real world that will not be the case.

Even if we had the SDI system deployed, there are bound to be a certain number of ballistic missiles get through in a saturation type operation, if they wanted to mount that type of operation.

Do you have any idea, have you run out of figures on threat analysis that would show what percent we have to stop to make the system worthwhile? In other words, what leakage can we afford with the system for it still to be a good system? And I know that you cannot do this on a straight numbers basis, because what you are really trying to do is cast it in the Soviet mind as to whether they can accomplish their mission or not, and try to create a deterrent, not just be absolute in battle itself. So the deterrent factor is a big one in casting doubt in the Soviet mind, but have you run out figures as to what minimum percentage would be acceptable and have it still pay to put the system up?

General ABRAHAMSON. In the end, of course, we are always dealing as you emphasize with the subjective judgment, where would we have sufficient capability so that the Soviet attack planner would feel that he just does not have confidence that he could go ahead. When we come to the classified session I would like to offer you some of the analysis that we have done that I think provides insight into that, and you can see that at much lower than 100 percent, it really does offer a very formidable defensive deterrent effect, which is, of course, what we are driving for, for stability in a crisis.

Now, to translate that into what the subjective decision would be, and would they attack or not attack is a very difficult question. You have to struggle with the criteria, but we can show you quantitative measures by which we are attacking that problem.

Senator GLENN. Thank you, Mr. Chairman. I am well over my 5 minutes. Thank you.

Senator WARNER. Mr. Levin.

Senator LEVIN. Thank you, Mr. Chairman.

First, Dr. Ikle, about the new interpretation given the ABM Treaty, I have a few questions. Earlier this year the Department of Defense made a report to Congress on SDI, a rather thick document, but it goes into a lot of detail about the ABM Treaty, and here is what it says about the ABM Treaty. It says the ABM Treaty prohibits the development, testing, and deployment of ABM systems and components that are space-based, air-based, sea-based, or mobile land-based. This is on page B-2. It says on page B-4 that

SDI field tests of space or other mobile base devices cannot involve ABM components or prototypes or breadboard models thereof. That was consistent with the interpretation which every administration and every DOD report and every report that I know of had followed since that treaty was entered into, for example, last year's ACDA arms control impact statement to the Congress said directed energy programs, when they enter the field test phase, become constrained by ABM Treaty obligations.

Now, all of a sudden, a couple of weeks ago, we are given a radically different interpretation of the ABM Treaty. Mr. McFarlane on Meet the Press announced that where new physical concepts are involved, that testing and development is approved and authorized by the treaty, and he repeated the treaty does indeed sanction testing and development of these new systems.

Now, those are diametrically opposed interpretations of the ABM Treaty. What is the current position of the DOD? Which interpretation is the correct one? And which one are you following?

Dr. IKLE. We are agreed in the administration that the correct interpretation, based upon careful analysis of the treaty text and the negotiating record, is the broader, less restrictive interpretation. That is to say, testing and development of systems based upon new physical principles is not prohibited.

You are right, Senator, that there was a fair amount of confusion in this in previous administrations as to what the treaty said and what was agreed to between us and the Russians on this issue. And what you read there from the DOD report of last spring did not have the benefit of this more careful analysis of what the situation really is. It is not quite correct to say, however, that the restrictive interpretation that you quoted has always been the one stated by previous administrations. For example, Secretary of State Rogers, in his report to the President and to Congress at the time of the ratification, stated at one point that development, testing, and deployment of ABM systems or ABM components that are sea-based, air-based, space-based are prohibited, meaning by this the components as listed in the treaty. Then he went on to say, deployment of ABM systems involving new types of basic components to perform the current functions is prohibited. He said deployment but not testing and development.

So in that particular place, as well as in other places, what we now have found is the correct interpretation has already been mentioned in testimony to Congress and in other reports.

There has been, however, an unfortunate confusion going back to that time which was then repeated because people did not go to the trouble of analyzing what the real situation was.

Senator LEVIN. He said deployment is prohibited.

Do you continue to accept that position?

Dr. IKLE. Yes.

Senator LEVIN. But you are saying that Rogers said that testing is OK?

Dr. IKLE. He lists development, testing, and deployment being prohibited for the traditional ABM technology, and then he goes on in the same passage to say that deployment is prohibited for new types.

Senator LEVIN. And you are reading, by that silence, that he meant that testing is OK?

Dr. IKLE. That would convey that interpretation, and there are other statements, but there are statements on both sides, I grant you that.

Senator LEVIN. Well, I do not know of too many statements on both sides. I am amazed, frankly——

Dr. IKLE. We have a collection of these and could present them to you. Really, you can quote them on both sides.

Senator LEVIN. Well, I think that would be useful if you presented it to the Congress as well as the negotiating record which has been withheld from us, and now we have heard from the negotiator who says that this interpretation is simply wrong.

Have you talked to the negotiator?

Senator WARNER. Let's call it the McFarlane and now the Schultz agreed upon position.

Senator LEVIN. Gerard Smith has written letters and made statements in the press which says that this broader interpretation of McFarlane is simply the wrong interpretation. He was the guy who negotiated the treaty.

Have you talked to Smith?

Dr. IKLE. Yes, we have. I have not, but others have.

Senator LEVIN. And you do not accept his memory on this?

Dr. IKLE. I do not because I have looked, and my colleagues have, at the negotiating record. In closed session we could go into details on what it says and quote from that negotiating record. But in short, for the purposes of this open session, our negotiators, including Ambassador Smith, tried, particularly toward the end of the negotiations, to have the Soviets agree to the restrictive interpretation, and it is clear from the negotiating record that they failed. There are also Soviet statements around 1972, after the treaty was signed, saying that such testing and development was not prohibited.

Senator LEVIN. Mr. Chairman, my time is up.

I would ask that the negotiating record as well as this opinion citing all of these other citations be made available to the Congress and to this committee.

Senator WARNER. The Chair is going to recognize Mr. Exon.

Senator LEVIN. Can we get that?

Senator EXON. Mr. Chairman, thank you very much.

General, I just have one further question at this time. In a great many statements, the Soviets frequently have alleged that the SDI program is a way to develop what they call space strike weapons.

What do you think the Soviets mean by the term "space strike" weapons? I am wondering if the Soviets' concern over this type of weapon may indicate that they are doing some things in the area of space-based offensive weapons that we might not currently be aware of.

What can either of you say in this regard in open session?

Dr. IKLE. That is an interesting speculation. There was a time when we were quite concerned. Do you remember that, Senator, about fractional orbiting systems that the Soviets might develop which could be described in some ways as space strike weapons. My hunch is that they tried to find a public formulation to attack the

Strategic Defense Initiative that people find attractive; namely, that it is really not a defensive system which people by and large in all countries would be sympathetic toward, but that there is really a hidden offensive intent, and it is for that reason that they attribute these offensive capabilities to the space-based weapons.

I think General Abrahamson could elaborate that the power, the kill capability of things that are in space does not compare in the threat of mass destruction to the things that we and the Soviets have based on the ground.

General **Abrahamson**. That is correct. We really are looking for weapon concepts that will be ideal for the specific tasks that were outlined, and that is to destroy a ballistic missile. Contrary to all of the marvelous cartoons and those things and the Soviet propaganda, a laser does not put a great deal of energy at its point of impact. It is like perhaps several hand grenades or a stick of TNT or something of that kind, quite adequate under certain conditions to destroy a booster, but certainly it is not a weapon of mass destruction. A neutral partical beam, which is another area that we are researching very carefully—and by the way, the Soviets are doing exactly the same thing in that area—while it could be a very capable weapon in space against electronic systems and perhaps even against warheads themselves, cannot even penetrate the atmosphere.

That does not mean that some energy of some of these kinds of systems might not be able to leak down to the ground. Yes, that is possible, but it would not be of the character or the kind that it would make an ideal weapon of mass destruction to be used against populations in the same way that a nuclear ballistic missile would.

Senator **Exon**. So if I am interpreting your answer to my question, what you are basically saying is that you believe that their talk about space strike weapons is merely an effort to cause confusion and deter us from our SDI work?

Dr. **Ikle**. Yes, Senator, to engender antagonism toward the ballistic missile defense.

Senator **Exon**. Thank you, gentlemen.

Thank you, Mr. Chairman.

Senator **Warner**. Thank you very much.

The Chair will ask several questions here, and then we will go to the additional direct testimony.

Now, General Abrahamson, the question with respect to the series of interpretations of the ABM Treaty, do you within your organization try to do those interpretations, or do you get them from Dr. Ikle?

And I am trying to get the interplay between you.

General **Abrahamson**. Sir, we have a series of checks and balances. My people or the people who are working as agents out in the laboratories in the program conceive of research programs, and a research program must have a test element. There is no research without testing. While they conceive of this, they are all checked very carefully by people outside of our program office. It is a whole process. The first point I would like to make is that outside of our program office is a dedicated organization in the defense research and engineering establishment that has had the responsibility for years of providing certification that not just the SDI, but all of our efforts do meet our international treaty obligations.

Dr. Lee Minichiello is from that organization, and it is not just himself. He has several technical people. We have a broader committee that includes policy representatives and people from our general counsel, that reviews all of these tests within the Department of Defense. As a further safeguard, since the Department of Defense is in a sense reviewing its own program, people from the Arms Control and Disarmament Agency, the general counsel in the State Department, others, and certainly the NSC, have the opportunity to review our reports and to make judgment about whether or not our interpretations are straying from what is correct.

Further, we provide both a classified and an unclassified report to the Congress where I guess we have 535 reviewers, so we have a great number of checks and balances on our system.

Senator **Warner**. All right, then, let me ask this conceptual question. Let's say that we are here today in terms of the options that we have with respect to getting to the goal over here of SDI, and somewhere in the middle here is the ABM Treaty.

Now, are there technologies and tests which could lead more directly to your goal of a defensive ballistic missile system which you have had to abandon because of the treaty?

General **Abrahamson**. The answer is yes. Actually, at this point in time we are more fund limited than we are treaty limited. In fact, our planning is of the nature that the very tests are conceived in this environment of staying within the treaty, and therefore, the planning has not jumped outside of the treaty.

Nonetheless, there are tests that we could conceivably do that would add to the simplicity and the ability to make this decision at some point downstream that could be conducted outside of the treaty, and we have forgone those.

Senator **Warner**. To recap, you have forgone certain technology and certain planned test programs because of the interpretation of the treaty that you received through this various network for treaty interpretation you described.

General **Abrahamson**. I think it is fair to say we have not forgone the technology, we have forgone being able to demonstrate it in such a direct manner and a way in which it could be very simply and directly convincing. And that is something that would occur downstream. That is not something that occurs today in our test program.

Senator **Warner**. Well, forgone technology, maybe that is best characterized as research.

Have you eliminated certain research programs because their testing and development would be, in the judgment of others, not an abrogation but a violation of the ABM Treaty?

General **Abrahamson**. No, sir, we are following the technology programs. We have had to in some places put restrictions on the pace and the direction and the way in which we would demonstrate those, but we have not forgone certain technology approaches. But we have modified how one would demonstrate that capability through testing.

Senator **Warner**. Now, if there were no ABM Treaty, would it be less expensive to get from, say, A to Z?

General ABRAHAMSON. It is going to be a very difficult, as I have tried to indicate, decision that an administration and that the Congress in the future is going to face. There are going to be a certain number of tests and facts that I believe they will demand, and in that sense, to the extent that we have to add additional tests of different kinds——

Senator WARNER. To get within the framework of the ABM Treaty?

General ABRAHAMSON. To get to the point where the Congress could examine and say yes, it does make sense, and you have demonstrated sufficiently that it makes sense to go into the development phase, to the extent that we will have to add tests to do that, then it could well cost us additional funding and additional time.

We have not identified a series of those kinds of tests at this point. I believe that we can get to that point where we can demonstrate it, but it will cost us additional resources.

Senator WARNER. I am going to try and rephrase the question in its most simplistic terms because this question is asked——

General ABRAHAMSON. I am not trying to avoid the question, I am trying to be very accurate.

Senator WARNER. No, no, it is a very sensitive one, but I think there comes a point in time where Congress must recognize that this program has added expense by virtue of the need of this Nation to comply with an interpretation of ABM as developed by the administration, is that correct?

General ABRAHAMSON. Yes, sir.

Senator WARNER. And in all probability, absent the ABM Treaty, there is a more direct way, purely from a technological standpoint and test development, to get from where we are today to a ballistic defense system.

General ABRAHAMSON. There clearly will come a time when we enter the development phase—and the development phase will require much more direct testing—that we will have to have a modified treaty in some way in order to proceed into that phase of the program.

Senator WARNER. Now, if you are to develop certain technologies, then you would have to have a modification of the treaty if those technologies are going to be a part of your ultimate system?

General ABRAHAMSON. Yes, sir.

Senator WARNER. Dr. Ikle, I am going to pass to you copies of this report that is now before the Congress as read by Mr. Levin, and that is the present document before the Congress. If we are to make changes by virtue of your testimony today, I want to give you the opportunity to have that language before you and tell us exactly how it is changed.

So let's take No. 1.

No. 1, reading for the record:

> The ABM treaty prohibits the development, testing and deployment of ABM systems and components that are space-based, air-based, sea-based and mobile land-based. However, that agreement does not prohibit research short of field testing of a prototype ABM system or component. This is the type of research that will be conducted under the SDI program.

Now, addressing yourself to that paragraph, the most recent position taken by the administration——

Dr. IKLE. Let me give you a quick answer and then submit one for the record.

I think the change would be that: however, the ABM Treaty does not prohibit the development and testing of components for ABM systems based upon new physical principles.

Senator WARNER. So it is the new physical principles under that section 8.

Dr. IKLE. Under subsection (d). And we will submit this in writing, how this page ought to be changed in light of the more careful analysis we have done of the meanings and scope of the treaty.

[The information follows:]

SDI AND THE ABM TREATY

Answer. The need for greater precision in our understanding of the limitations of the ABM Treaty recently caused the U.S. Government to reexamine the Treaty as it relates to future systems based on "other physical principles." These devices are addressed in an agreed statement to the Treaty as "ABM systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers or ABM radars." This review led to the judgment by the President that a reading of the ABM Treaty that would allow the development and testing of such systems based on other physical principles, regardless of basing mode, is fully justified. As we have stated in the past, while the U.S., of course, reserves the right to conduct its research program under this interpretation at some future time, the President has said that for now the SDI program will be conducted in accordance with a restrictive interpretation of our obligations under the Treaty. (This restrictive interpretation treats ABM devices based on other physical principles and capable of substituting for ABM interceptor missile, ABM launchers, or ABM radars as "ABM components" within the meaning of Article II of the Treaty, and therefore subject to the provisions of the Treaty, including Article V.) Consistent with that statement, the assessment of compliance of SDI with the ABM Treaty continues to apply the more restrictive Treaty interpretation as a matter of policy, although we are not legally required to do so, in evaluating the experiments in the SDI program. Therefore, statements regarding compliance with Treaty provisions should be understood as based upon the restrictive interpretation. Thus, the language in question does not change.

Senator WARNER. Now, turning to the second one, which is on page B-4:

> The definition of development coupled with article V led to the prohibition of field testing of ABM systems and components or their prototypes and breadboard models which are other than fixed, land based. SDI field tests of space or other mobile-based devices cannot involve ABM components or prototypes or breadboard models thereof. All SDI category 2 experiments must meet this criteria.

Now, what is the variation, if any, from that statement?

Dr. IKLE. As I see it, I think we advanced that earlier in some language that was sent to you.

Senator WARNER. To whom?

Dr. IKLE. I think in part also the language was sent to Senator Levin.

Senator WARNER. That is not part of the record.

Dr. IKLE. We can make it part of the record, that ABM components—ABM interceptor missiles, ABM launchers, or ABM radars, as described in article II—and devices capable of substituting for ABM interceptor missiles, ABM launchers and ABM radars are also treated as ABM components under the treaty.

Senator WARNER. You are reading from what?

Dr. IKLE. From our answer to a related question, a question that related to that point, that category 2.

Senator WARNER. Now, being an old lawyer, I have gone over a thousand records. Your answer to whom? I mean, reading this record cold, other Senators want to be able to track this.

Dr. IKLE. I propose that we again submit for this page of the record a statement that, if required, would modify what you have there in the report.

Senator WARNER. So you will send forth a modified answer.

Dr. IKLE. Right.

Senator WARNER. But you were about to give us a short answer for the interim period for Senators studying this issue, and that short answer is what?

Dr. IKLE. The short answer is this category II issue here is what are components and what are not components, and it does not go, as I just now reread it.

Senator WARNER. What does not go?

Dr. IKLE. The paragraph at the bottom of page B-4 does not go to the question of systems based on new physical principles.

Senator WARNER. So you are going to send up modifications to the paragraph?

Dr. IKLE. Right.

Senator WARNER. Mr. Levin, since they were your questions and I have endeavored to clarify them for the record, if you wish to pursue both of those. Before doing so, are there other representations or statements in this report by the administration which would require change in view of the most recent interpretation as adopted by the administration?

Dr. IKLE. We shall review that, Mr. Chairman.

Senator WARNER. Now, I think that this review should be conducted fairly expeditiously and Congress be provided a copy.

Mr. Levin, would you like to revisit this question?

Senator LEVIN. Yes; thank you, Mr. Chairman.

I understand that the President is going to continue to comply with the earler interpretation. Is that true?

Dr. IKLE. Yes, Senator. In fact, the program, of course, has been designed to fall within the constraints of the interpretation that was thought to be the correct one previously, and we are not making changes now in this program as a result of what we now see as the correct interpretation.

Senator LEVIN. Why are you not, if it is the correct interpretation, why do you not fit the program to follow the correct interpretation rather than the incorrect interpretation?

Dr. IKLE. Well, there are a number of considerations. First of all, General Abrahamson and his team have developed the program, and maybe he may want to answer this, but there are no compelling requirements at this time to make changes in the research program. I think in part he touched on that problem already in your answer to the Chairman's question.

Senator LEVIN. Well, in other words, when the time comes in this program, if it does, and it bumps up against the old interpretation, at that point you are going to drop the old interpretation and put the new one in place?

Dr. IKLE. Well, that I cannot answer. That may be in the more distant future. But when the time comes that it would be either far more expensive or lead to far greater uncertainty as to the results and the progress we are making, or a combination of the two, then this President or a future President may decide to be guided by the correct legal interpretation.

Senator LEVIN. Why would the President, of course, be guided by the correct legal interpretation?

Dr. IKLE. And permit an expansion of the program into these areas which we previously, based upon an incorrect interpretation, felt were prohibited?

Senator LEVIN. Why would the President not obviously follow what he sees as the correct interpretation?

Dr. IKLE. Do you mean right away?

Senator LEVIN. At any time.

Dr. IKLE. Well, obviously he wants to follow the correct interpretation, but we do not have to do everything that is permitted. The treaty does not force us to do it.

Senator LEVIN. Do you not want to do everything that is correct?

Dr. IKLE. The treaty is permissive here. Obviously we are not forced to do this kind of testing by that treaty.

Senator LEVIN. So even though the treaty allows you, you claim this negotiating record which has never been made available to the Congress allows for an amendment of the actual language of article V which prohibits the testing, development, and deployment, flat out prohibits it, you say that is modified by something in that negotiating record, even though the negotiator denies it. You are saying that, well, even though that negotiating record that is somewhere out there allows this, that you may not do it anyway, even though it is the correct thing to do. I find a real confusion here, frankly, in the administration's position. It is either the correct interpretation and you are going to let the program develop according to it, or it is not the correct interpretation and you are going to constrain the program.

And I think you are basically hedging still, and frankly, I am glad because I think your new interpretation is off the wall. And so I am delighted you are hedging. I mean, I do not want to kid you as to where I am on that.

Dr. IKLE. I have to disappoint you, Senator. We are not hedging. We are convinced it is the correct interpretation.

Senator LEVIN. But you are not going to put it into effect yet.

Dr. IKLE. It is not contrary to any article of the treaty. The treaty is somewhat ambiguous on it, and that is why I have to go to the negotiating record.

Senator LEVIN. Does it not prohibit the testing, development, and deployment?

Dr. IKLE. Not of the parts that are based on new physical principles.

Senator LEVIN. The new physical principles is not in the treaty itself, is that not correct?

Dr. IKLE. This would take a long time . . . But the treaty itself lists what were seen then as the components of ABM systems, interceptor missiles, launchers, and radars.

Senator LEVIN. In fairness to the treaty and to the agreed statement, does it not say that the purpose of that agreed statement (d) is in order to ensure fulfillment of the obligations, not to deploy ABM systems and their components except as provided in article

III? I mean, that is the way the agreed statement (d) starts. You folks just want to ignore that.

Dr. **Ikle**. There is very good and detailed testimony, which I would not want to improve upon or repeat, by the expert lawyers. Judge Sofaer testified before the House Foreign Affairs Committee. We can submit here the full testimony which goes through this step by step, traces how these articles are interconnected, how the meaning of the treaty applies to the traditional components and not those of new principles.

Senator **Levin**. You have not answered my question.

Why do you not give General Abrahamson and his folks the new interpretation and tell them to design his program accordingly since it is the correct one? Why do you not just do it, if you are not hedging? Why do you not do it?

Dr. **Ikle**. Well, we are not hedging on legal interpretation. The President and we have not seen a need now to exploit, to take advantage of, everything that is permitted. There are many areas under the treaty which may be permitted. We do not have a single ABM site either. But it is quite clear the treaty does permit the single ABM site, and the Soviets do have one.

Senator **Levin**. General Abrahamson, is your program affected at some point by the decision whether to adopt the narrow or the broad interpretation?

General **Abrahamson**. Sir, at some point the program is affected by either interpretation, and there will be a time that in fact we will have had to achieve, hopefully, a cooperative transition with the Soviet Union.

Senator **Levin**. But is your program affected by the narrow interpretation earlier than by the broad interpretation?

That is a very straightforward question.

Dr. **Ikle**. I would say yes, frankly.

Senator **Levin**. Even Dr. Ikle would say yes.

Dr. **Ikle**. It really goes over into a political question, but—and the General has very well explained it in much greater detail than I could—because of the kind of degree of certainty you may want to have about certain stages of development, testing will help you get the additional certainty.

Senator **Levin**. Would you agree, General, that your program would be constrained earlier by the narrow interpretation than by the broad interpretation?

General **Abrahamson**. At some point it would.

Senator **Levin**. I said would it be constrained earlier?

General **Abrahamson**. Yes, sir, at some point it would be constrained earlier, at an earlier point than another.

Senator **Levin**. Is that point earlier?

General **Abrahamson**. Senator, I still want to say that we can conduct a program to provide evidence so that a compelling and useful decision can be made. That is the way we started out, and we can do that.

Senator **Levin**. I understand that, but my question is——

General **Abrahamson**. It would be a much more complex and difficult decision for you to understand.

Senator LEVIN. Now, my question is, will your program be constrained at an earlier point by the narrow interpretation than by the broad interpretation?

General ABRAHAMSON. The answer is yes, particularly depending upon how, what kind of criteria and information you need in order to make an effective decision on going into the next phase.

Senator WARNER. Let me try and just clarify for the record, and this is rather pedantic. In reference to the ABM Treaty, we have got the original, we have got the old, we have got the new, and we have got the McFarlane versions. For someone trying to read through this, what is the original or the old interpretation? Is that the one in this report to Congress?

Dr. IKLE. I think by and large in our discussion of it the last few minutes, we have referred to the old interpretation as the one that is more restrictive, that would prohibit testing and development of systems based upon new physical principles, and the one that is reflected in the report that Senator Levin read from. Then there is a new or less restrictive interpretation, the one on which the State Department legal counsel testified and the one that the President determined is the correct interpretation.

Senator WARNER. All right, now, where is McFarlane in that?

Dr. IKLE. He did indicate this less restrictive interpretation was the correct one.

Senator WARNER. The less restrictive——

Dr. IKLE. I mean, we all agreed in the administration that the correct interpretation is that interpretation which permits testing and development of systems based on new physical principles.

Senator WARNER. And that present interpretation which is guiding General Abrahamson is different than the one that you just worked on here in the report to Congress?

Dr. IKLE. Yes.

Senator WARNER. And you are going to tell us exactly how it differs?

Dr. IKLE. We will submit for the record how this would affect the language in the report.

[See p. 41 for insert.]

Senator WARNER. Now, General Abrahamson, you said—and I copied it down as best I could—sometime you are going to come up against this problem, and you are hopeful that cooperation or transition with the Soviet Union would resolve it.

Now, what did you mean by that?

General ABRAHAMSON. I think the policy under which the administration is operating, and obviously the reason that we are discussing it with the Soviet Union now is that we would hope that we can get past this propaganda stage, and that they will understand that it is in their interest as well as our own to move to a more defensive type of deterrent. Once that is achieved, hopefully we will then be in a position to, in a negotiated way, modify the treaty so that both we and they could move into a defensive regime.

At the same time, people have indicated that while that is a hope, we would not accept the idea that they would hold a veto over our ability to proceed.

Senator WARNER. Now, just for the record, I indicated that the Levin letter was not before the Congress. I understand that it was inserted in the record in connection with the confirmation of Mr. Hicks. So for those who want to find it, it is found there. But we can also include it in this record, can we not, Mr. Levin?

Senator LEVIN. Sure.

[The information referred to follows:]

SDIO TERMINOLOGY

Senator LEVIN. Congress and the NSC have mandated that all SDI research be conducted in full compliance with the 1972 Antiballistic Missile (ABM) Treaty, which prohibits the development, testing, and deployment of ABM systems or components that are space-based, sea-based, air-based or mobile land-based. The SDIO has agreed that field tests of space- or other mobile-based devices cannot involve ABM components, prototypes or breadboard models thereof.

In order to exercise effective oversight of SDI's compliance with the ABM Treaty, the SDIO has to have detailed definitions of a number of key terms in the way they are applied to all SDI experiments involving non-fixed, land-based devices.

I would like to know in an unclassified form how the Department of Defense and the SDIO define the following terms as they relate to the 1972 ABM Treaty:

(a) Component
(b) Subcomponent
(c) Prototype
(d) Breadboard model
(e) Field test
(f) Laboratory research
(g) Adjunct

The answers should inlcude:

(1) A detailed definition and explanation of the distinctions between "component" and "subcomponent" "prototype" and "subcomponent," "breadboard model" and "subcomponent", "adjunct" and "Component," and the distinction between "field test" and "laboratory research."

(2) Whether a prototype must perform the complete function of an ABM component.

(3) Whether a device that significantly contributes to the performance of an ABM component as defined in article II of the Treaty is an ABM component.

(4) Whether a device that can perform an ABM mission is an ABM component.

(5) Whether an ABM component, subcomponent, prototype, or adjunct must be verifiable by national technical means.

(6) Why the following experiments in SDI are not field tests of prototypes of non-fixed land based ABM systems or components:

1. Boost Surveillance and Tracking System Experiment
2. Space Surveillance and Tracking System Experiment
3. Airborne Optical Adjunct Experiment
4. Space-Based Kinetic Kill Vehicle Experiment
5. Space-Based Railgun Experiment

(7) Whether any of the experiments in SDI are considered to be "based on other physical principles" under the ABM Treaty. If so, what is the U.S. position as to the coverage of these experiments under the treaty?

Dr. HICKS. 1. "ABM components" are ABM interceptor missiles, ABM launchers, and ABM radars and are described in article II of the treaty. Devices capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars also are treated as ABM components under the treaty.

Neither "laboratory research" nor "field testing" are terms used in the ABM Treaty.

For a "prototype" to be limited by the ABM Treaty it must be a prototype of an ABM system or component. Regardless of whether a device is labeled "prototype," "breadboard," "test bed," or "preproduction model," or any other term of art, the determination of what treaty restrictions apply is based on whether it constitutes an ABM component under the treaty, or is capable of substituting for an ABM component. Finally, the word "adjunct" is not used in the ABM Treaty. In the ABM Treaty negotiating record, the term "adjunct" is referred to as a device that could be used in conjunction with an ABM component, but that could not perform all the functions of, or substitute for, the component.

Neither the treaty nor the relevant negotiating record refer to the term subcomponent or breadboard mode.

2. For any device, whether labled "prototype" or some other term of art, to be limited by the ABM Treaty, it must constitute an ABM system or component (an ABM interceptor missile, ABM launcher, ABM radar), or a device capable of substituting for such an ABM component.

3. No. Only devices which are capable of substituting for ABM components are covered in this context.

4. Again, the criterion for application of the treaty is whether a device constitutes an ABM component or is capable of substituting for a component.

5. No. The ABM Treaty contains no such requirement.

6. As described more fully in the report to Congress on the Strategic Defense Initiative (1985), there are three basic types of research and development activity that are permitted by the ABM Treaty: (1) conceptual design or laboratory testing; (2) "field testing" of devices that are not ABM components or prototypes of ABM components; and (3) "field testing" or fixed land-based ABM components. The Boost-Surveillance and Tracking System Experiment, Space Surveillance and Tracking System Experiment, Airborne Optical Adjunct Experiment, Space-Based Kinetic Kill Vehicle Experiment, and the Space-Based Railgun Experiment all fall within the second category of ABM Treaty-permitted activity.

7. Some of the experiments in the SDI program will involve devices considered to be "based on other physical principles." Any such experiment will be consistent with the ABM Treaty.

In a more general vein, the Department of Defense has exercised effective oversight of the SDI research program as it is affected by the ABM Treaty and has judged the compatibility of our SDI experiments with that treaty on a case-by-case basis by making use of several reasonable working principles. These principles are discussed in the Report to Congress on the Strategic Defense Initiative (1985).

Senator WARNER. Now, I think we have about concluded, and Dr. Ikle, I say most respectfully on this question of the elimination, as you call it, that we will eventually eliminate the threat posed by ballistic missiles that you might consider recasting that as eliminating the possibility of a disarming first strike. I think that is the goal that we are seeking as opposed to preventing the penetration of a single weapon. I think a number of the Members of Congress today, of the Senate, have shared with you their grave concerns about this concept of sharing our technology with the Soviet Union, and I join them. Senator Hart has spoken to it and others have spoken to it.

Perhaps this hearing can be of some benefit to indicate that here there are some deep-seated feelings on those two aspects of the policy which I think, quite candidly, undermine the administration's credibility, and we need to restore the maximum amount of credibility in order to get the funding that General Abrahamson needs.

I think there will be a direct relationship between that credibility and the action by the Congress on the SDI budget that will be submitted in late January or early February.

Gentlemen, I thank you.

Yes, General Abrahamson.

General ABRAHAMSON. Sir, while you are speaking of credibility and since I believe that there is no real credibility to the claims by some of the people who seem to be able to jump into instant celebrity status merely by saying some part of the SDI is impossible.

Senator WARNER. Yes.

Forgive me. We will resume the hearing and receive direct testimony on that issue after the vote.

Senator LEVIN. Mr. Chairman, will there be additional opportunities for questions, and if not, will you leave the record open?

Senator WARNER. We will leave the record open.

Of course, hearings on this subject are going to continue for several weeks.

Senator LEVIN. I meant in terms of these two witnesses.

Senator WARNER. Yes, that record is open for questions.

Senator LEVIN. Will there be additional questioning today of them?

Senator WARNER. Yes, after the vote.

So we will adjourn for about 15 minutes.

[A brief recess was taken.]

Senator WARNER. We will resume the hearing now.

Dr. Ikle, I want to be respectful of your time constraints. If you can bear with us for just a minute until Mr. Levin returns, we will ask General Abrahamson to interrupt his presentation briefly so that we can provide him with a brief question opportunity, and then try and accommodate both of you.

[Pause.]

Senator WARNER. Senator Levin, Dr. Ikle has remained at our joint request.

Mr. Levin, we are hopeful you can make this fairly brief.

Senator LEVIN. Thank you.

I wonder if we can get an estimate from Dr. Ikle as to where we are vis-a-vis the Soviet Union in the SDI area. Are they ahead of us in that narrow area of ballistic missile defense? Are we ahead of them? Are we about even? Where are we?

Dr. IKLE. They are ahead in, of course, the deployment of traditional types of ballistic missile defense. They have a system around Moscow and we do not. They have developed an infrastructure with their radars, including one in violation of the ABM Treaty. They have conducted research on the technologies that are a part of General Abrahamson's program far longer than we have. Maybe General Abrahamson wants to gauge further what the differences are, and I think you have scheduled in this series, as the chairman mentioned, a review of the Soviet ballistic missile effort.

But it is clear that they have been working on it vigorously in the last 10 years while we have scaled down our efforts.

Senator LEVIN. I am just talking about the area——

Dr. IKLE. This is the area of advanced technology.

Senator LEVIN. Are you saying the Soviets are ahead of us?

Dr. IKLE. They have been working on it vigorously.

Senator LEVIN. Let me repeat my question.

Are you saying the Soviets are ahead of us in the area covered by the SDI Program?

Dr. IKLE. In some parts.

Senator LEVIN. Overall, in the area covered by the SDI Program, are the Soviets ahead of us?

Dr. IKLE. It is not possible to make an overall balanced judgment, particularly not in an open session, but we will have further testimony for you on the Soviet program.

Senator LEVIN. Are you saying that it is not possible to make an overall assessment on who is ahead in the SDI area, or that you cannot do it in open session?

Dr. IKLE. The latter primarily.

Senator LEVIN. So that when the President said that they are 10 years ahead of us, he was not referring to the SDI area?

Dr. IKLE. He was referring to the effort they made. They started 10 years earlier, in essence.

Senator LEVIN. They are not 10 years ahead of us. They started 10 years before us.

Dr. IKLE. He was also including—I would have to look at the exact quote—the more traditional ABM systems and the infrastructures that I referred to, the radars and other things that they have been preparing.

Senator LEVIN. You are saying that the impression left by the quote—and I will try to get it——

Dr. IKLE. It would be helpful if you had it for us.

Senator LEVIN. The Soviet Union is about 10 years ahead of us in developing a defensive system. That is the exact quote that I have.

Dr. IKLE. The operative word there is "developing." They started, as I said, 10 years ahead of us.

Senator LEVIN. So you are saying they are not 10 years ahead of us now but that they started 10 years ahead of us.

Is that what you are saying?

Dr. IKLE. What is the meaning they are not 10 years ahead of us now?

Senator LEVIN. This says the Soviet Union is about 10 years ahead of us in developing defensive systems.

Dr. IKLE. They started 10 years earlier and presumably accomplished a great deal in this area. Whether in every part of technology they are more capable now or not would require more detailed evaluation, and that is not what the President was referring to.

Senator LEVIN. So the President is not intending to imply there that in the SDI area, that they are now 10 years ahead of us?

General ABRAHAMSON. Let me just——

Senator LEVIN. I want to get Dr. Ikle.

General ABRAHAMSON. Sir, their defensive technologies—there are many, many defensive technologies. We are not only pursuing advanced lasers and some of these concepts, we are also pursuing some more conventional concepts. The Soviets are taking some different directions, as they always do. They have built on——

Senator LEVIN. General, I understand all of that. They are moving in different directions. I am only talking about in the SDI area. I want to know whether or not they are now 10 years ahead of us in that area, and you are saying no, they started 10 years ahead of us, and that is a very different impression than the President conveyed.

Dr. IKLE. Well, you have to give some meaning to the phrase "they are now 10 years ahead". Do you mean by that, Senator, that if they broke out of the treaty, they could get some important defensive capabilities 10 years before us?

Senator LEVIN. I think the meaning is clear. You quibble on words. The meaning is, it would take 10 years for us to get to where they are now in SDI.

Would it take us 10 years to get to where they are now in the SDI area?

General ABRAHAMSON. Building on the kind of technology that they have today—and by the way, intelligence people would be the ones that could, I think, put this in better perspective, but my understanding of what they are saying——

Senator LEVIN. Who is they?

General ABRAHAMSON. Our intelligence people, that they could have a fairly substantial defense against ballistic missiles. It would be a different character than what we are talking about right now, but a fairly substantial defense in the late 1980's if they chose to. The fact that they started early and now have built a full command and control capability that is nearly ready to go ahead now, that is part of a defensive system.

Senator LEVIN. But now, let's get to my question because we are going toward SDI as the defensive system, and my question is, are they 10 years ahead of us in developing an SDI type defense system?

General ABRAHAMSON. They are, in certain areas.

Senator LEVIN. And in other areas, they are not?

General ABRAHAMSON. In some areas, we have a fundamental technical advantage, but we have not moved to apply those technical advantages to the final solution.

Senator LEVIN. General, would you say overall that they are 10 years ahead of us in developing an SDI type defense?

Dr. IKLE. I think the answer to the question, as I understand it, the way you mean it now, is yes.

Senator LEVIN. General?

General ABRAHAMSON. Sir, I think you are trying to get too simple an answer. I think it is fundamentally more complicated than what you have asked, Senator, and that by trying to make it a simple black and white, yes or no answer, you are trying to elicit the wrong answer.

Senator LEVIN. I am trying to find out what the President means. He is trying to elicit a certain response. He tells the world the Soviet Union is about 10 years ahead of us in developing a defensive system. He is trying to create an impression, and I would say that your answer to my question is that my question is too simple. I would say that that statement is too simple.

General ABRAHAMSON. I think that it is an accurate statement in the sense that the Soviets could have a defensive system built on their earlier start much sooner than we could. In fact, they could have that in the late 1980's. It would be built first of all on traditional technologies, but in addition to that, they have very substantial advances in some of the advanced systems.

Senator LEVIN. But do we have advances in some of the advanced systems?

General ABRAHAMSON. We have fundamental technical advantages.

Senator LEVIN. Why do we not ever emphasize that?

General ABRAHAMSON. I have, sir.

Senator LEVIN. Well, that sure does not come through in this statement.

Dr. IKLE. The President has also emphasized that very much, very much, at the beginning, when he made his first statement about the initiative.

Senator LEVIN. I have a few additional questions of General Abrahamson, and I will insert questions for the record for Dr. Ikle.

Senator WARNER. Dr. Ikle, we thank you very much.

Senator LEVIN. I thank Dr. Ikle for staying, too.

Shall I just ask a few additional questions?

Senator WARNER. Well, I really feel that we have got this second panel tied up, and they are about to come forward here.

Senator LEVIN. I would like to ask those for the record as well. General Abrahamson and I, we communicate through the record frequently.

General ABRAHAMSON. One of these areas of fundamental technical advantage is, by the way, the one we are saying that we cannot do, and that is this group, and therefore, I think that is important to understand.

Senator WARNER. That is well spoken, General.

Now, General Abrahamson, I know that you have been anxious since early this morning to try and have the opportunity to publicly state your views on the issues of the computers.

You take such time as you need now.

General ABRAHAMSON. Thank you, sir. I appreciate very much the opportunity to allow some additional experts to be heard. It is my hope, of course, that the press and others will see that there is a very substantial body of opinion that is very well founded on just how difficult and how best to proceed in the difficult area of computers. So I would like to introduce three people who have had access to our program and who I think will provide some very credible counters to what I consider to be a very pessimistic view of what our technology can do at this point.

The first one I would like to introduce is Dr. Dick Lau, a Ph.D. from Yale who has served on the Cal Tech faculty and is now at the Office of Naval Research. Now, the one important activity that Dr. Lau has been very active in for us is bringing together some of these experts from outside to give us advice on the systems, and in fact, he chaired the effort that Dr. Parnas attended and then left.

So I would like him to offer some of his own opinion based upon some of the information presented to each of them, but also his own opinion on the program.

And I would also then like to introduce Frederick Philip Brooks, who is a professor of computer science at the University of North Carolina, Chapel Hill. He has an industrial background as well as an academic background. In fact, he was the manager in charge of developing the IBM system, the 360 system, which is a whole compatible family of computers. An important relevant statistic is that while people have said that developing a 10-million line-of-code system may well be impossible, the 360 system operates essentially on 10 million bytes of software, and its operating system to make that work.

And finally, Dr. Lipton from Princeton is a professor of computer science. He is an expert in architecture for computers, and particularly the application of some of these architectures to large-scale integrated circuits, what we call VLSI, and he has the added distinction of having once been a student of Dr. Parnas.

So I would like to invite you all to come up, and I will just move out of the way.

Senator WARNER. Why do we not just receive your brief testimony which can be expanded for the record, in order of your introductions.

STATEMENT OF RICHARD LAU, OFFICE OF NAVAL RESEARCH

Mr. LAU. My name is Richard Lau, from the Office of Naval Research, and I would like to say something simple but I hope compelling.

I perhaps should start with an analogy and ask you to suppose you are a combat general faced with the prospect of attacking or not attacking, if you so decide, a difficult objective. What do you do? Well, you might pull your copy of Clausewitz out of your pocket and consult that, and that might be useful. You might communicate back to the staff college and ask the theorists—the warfare theorists—what their opinion of your situation is and how you might proceed. But I think what you would in fact do is consult your best combat officers, those both above and below you with real experience in taking real objectives.

A case can be made, to shift gears now, from combat to software, that there are four great software gurus in this world, the people who founded the subject and who have probably collectively made the greatest contribution to the subject. One of them is sitting next to me, and I apologize for calling you a guru. That is Fred Brooks. The others are Harlan Mills of IBM, Vic Vyssotsky of Bell Labs, and David Parnas, to give him his due, of the University of Victoria.

[Additional information follows:]

On the matter of SDI software, I do not know Mills' views. Of the remaining three, Parnas is the "staff college theoretician" and Brooks and Vyssotsky the "combat officers" with great experience in the construction of large, real-time software systems. Parnas advances what are essentially theoretical arguments that dependable SDI battle management software cannot be constructed. Vyssotsky, who has very extensive experience in large telephone system software and who successfully developed the Safeguard software, has told me that he sees no reason why SDI software cannot successfully be developed. Further, after hearing the results of our summer Eastport Group Study, in which both Professor Lipton and I participated, Vyssotsky observed that we had made surprising progress and that his optimism was reinforced. I believe that Professor Brooks will follow me with testimony substantially endorsing Vyssotsky's views.

Senator WARNER. The fundamental issue before us is the program, SDI. An integral part of it is the computer software system. What is your judgment with respect to the U.S. technology achieving the goals that are now being laid down by General Abrahamson?

Mr. LAU. My judgment is that there is no reason why we should not be able to build the computer hardware and software system to support SDI battle management, and I was going to cite the names of the four people whose opinions count more than mine.

Senator WARNER. That judgment is predicated on what experience that qualifies you as an expert?

Mr. LAU. Fifteen years of computing experience, mostly in the management of basic research in computer science.

Senator WARNER. Thank you very much. You are qualified as an expert witness.

Now we will take the next gentleman.

STATEMENT OF FREDERICK PHILIPS BROOKS, JR., KENAN PROFESSOR OF COMPUTER SCIENCE, UNIVERSITY OF NORTH CAROLINA, CHAPEL HILL

Mr. Brooks. I am Fred Brooks from the University of North Carolina at Chapel Hill.

I have come extemporaneously to this hearing from another meeting on another subject.

Senator Warner. Well, we are grateful. If you could state your history that qualifies you as an expert witness and then give us your judgment.

Mr. Brooks. Twenty years ago, about a thousand very able people under my direction built the largest software system that had been built at that time, the operating system and compilers for the system/360 family of computers. This, at the time of delivery in 1965, was about 10 million bytes of code. This system and its evolutionary descendants are still in use today as the MVS operating system for almost the entire IBM middle and large product lines. We have been through a lot of learning in that process.

I would like to make several points, but I will state the net position first. I see no reason why we could not build the kind of software system that SDI requires with the software engineering technology that we have today.

Now, may I make a few other brief points. I had a chance to discuss this issue in a public session with my good friend, David Parnas who, was at Chapel Hill some years as a colleague.

Senator Warner. And for the record, he is——

Mr. Brooks. He is Lansdowne Professor of Computer Science at Victoria University.

Senator Warner. And he is referred to extensively in an article which we will incorporate in the record at this point, or at some point in this colloquy, in the Washington Post today.

[The information follows at the conclusion of this hearing.]

Mr. Brooks. He has published a set of eight little papers, which are appearing in Software Engineering News and the American Scientist, in which he details his technical arguments as to why he thinks SDI software is not feasible. So the sponsors organized a panel discussion on the subject at the Eighth International Conference on Software Engineering in London this past August. It was my opportunity to appear on the panel. Professor Parnas and I agree on some things, and we disagree on some things.

The foremost matter on which we agree is that I, like he, believe there is no magical software technology coming over the horizon. I see no development—artificial intelligence, new languages, work stations environments, program verification, and so forth—I see no single development that will give us as much as an order of magnitude improvement in our ability to build software in the next decade.

Therefore, I grant that if one cannot foresee how to build the SDI software with today's technology, one should not believe that he can build it at all. I think the central technical question is, "Can it be built with today's software engineering technology?"

Now, I think there are some straw men in Professor Parnas' arguments. One of them is, he seems to take as a criterion of success the construction of an absolutely perfect system that has no flaws. I think the real requirement is that it be perfectly guarded against catastrophe; but if the system, for example, assigns two weapons against one threat when it should have assigned one, that is not a flaw one would lose sleep over. He argues that since it has to be perfect, and since such a system by its very nature is very complicated, then it cannot be exhaustively checked and tested.

But we cannot exhaustively test even a half-inch square microchip. In fact, we use a variety of testing techniques to establish the reliability of everything we do in the computer field without exhaustively checking all the possibilities.

Now, I would not be so bold as to assert that the SDI software can surely be built. What I would say unequivocally is that it is much too soon for gloom. The problem is not sized. One hears people talking about 10 million lines of source code; but I have seen no basis whatever that leads me to believe that 10 million is anything other than a guess.

We have many years of experience with the testing of complex software systems—not only testing but gaming, in which adversaries take computers and put them in the same system with the system that one is testing, using the computers to make up disasters to which the system under test has to respond.

That was done on the *Apollo* program. IBM delivered five system/360 model 75 computers to that program. Four of them were used for planning and simulating flights. One was in the hands of the black hat team. They used it to inject made up troubles into the system. All day every day, for years, the *Apollo* ground controllers practiced against the troubles that the black hat team synthesized with their computer.

The SDI system has a major difference from the *Apollo* system: it is against an intelligent adversary instead of against nature. But we have experience with many kinds of software systems that are military and defense systems, and we have testing procedures that are routinely used for those.

The next point I would make is that the hazards and uncertainties that Professor Parnas describes are common to all defense systems, present and future. You do not know what the opponent is going to do; you do not know what technology he will bring; you do not know which parts of your system he will knock out; you do not know which parts of your system will be electronically jammed. These are the hazards that we face in all the defensive systems that we have today.

This is true not only of our defensive systems; these hazards face us in our retaliatory systems. We live today under the shadow of those uncertainties.

The fact that a defense is difficult to build and its effectiveness when called upon is ultimately uncertain is not a reason not to attempt one.

I myself have not arrived at an informed personal opinion on the wisdom of the whole SDI system, and I am not sure anyone can at the present stage. Nor have I an informed opinion on the feasibility of developing the hardware. But with respect to the software I see no reason why I or any better software manager and there are many—could not build such a system.

Some properties make this system easier to build than many others. There are some pluses. Defensive systems have some advantage over offensive systems in terms of the limited types of catastrophes that can happen. I believe that the most important ingredient in building a very large software system is plenty of calendar time in which to do it. Because the hardware will take a long time, I think the software people have a chance of having enough calendar time. I have talked to people who have been working on the system—and I have not worked on the system—who see the possibility of a high degree of decentralization and independence of operation of the parts of the software system. That is a tremendous advantage.

The task should have plenty of priority. It should have plenty of resources. Something which I consider a very great advantage is that everyone believes it will be hard. Therefore, the danger of brash overconfidence, which has characterized many software efforts, is radically diminished. Everyone thinks it will be hard, so the builders will go at it with much caution, close attention, and a limited and modest set of objectives.

That is the best insurance of success.

I think it can conceivably be done. I agree with Professor Parnas that it cannot be done in a business-as-usual military system-building environment. I think it will have to be a Skunk Works of some kind, as the *Polaris* system was, for example. That is the only hope that I see for building such a system. But I see no reason why we should not proceed on with the feasibility investigation and a preliminary design to find out what the troubles are.

Senator WARNER. Thank you, Doctor.

For the record, Skunk Works is a laboratory I think primarily under the jurisdiction of Lockheed that has developed some very fine aircraft.

Now, Dr. Lipton, if you could briefly state your credentials and your views.

STATEMENT OF RICHARD LIPTON, PROFESSOR OF COMPUTER SCIENCE, PRINCETON UNIVERSITY

Mr. LIPTON. Yes; I am professor of computer science at Princeton University, and I was on the panel that was convened in the summer to look into these problems that Professor Parnas wrote about his attack against the SDI plans. I would like to say that one of the things that he said in his notes is, just so I can quote a little piece of it——

Senator WARNER. You were going to tell us a little bit about your experience. When you go into a court and you have an expert witness, you have to lay a foundation.

Mr. LIPTON. I have been a computer scientist for approximately 15 years and involved in a variety of projects.

He said simply that the strategic defense system cannot be obtained by the classic systems that you are considering, as he wrote to the office. I think that is in a sense the key point here that the critics, and Professor Parnas included, have looked at the earlier Fletcher report and earlier descriptions of potential SDI configuration systems, and have pointed out that those systems would have grave problems, and I think he is actually quite accurate on that. I think what we cannot do is build a strategic defense system that is one large monolithic system. For example, if we were going to operate in a conventional battlefield, I do not think anyone would seriously consider that the general aim every gun for every soldier and decide what every soldier does at every point in time, how he walks, where he looks, what he does. That is clearly a crazy idea, that kind of centralized system which does not work.

No one suggests we do that for banking. We all have automated tellers, probably, at our banks. We all have lots of banking systems we use. They are not all tied together to one monster machine in the United States. If we did that, we know what would happen. That machine would go down at some point and there would be no banking service for quite a while.

What I think you need to point out to Dr. Parnas and other critics, and what they need to realize is that there are many ways to structure and build a strategic defense system. One of the findings I think of the panel this summer was just that, that the way to build the system that will have a very good chance of success is to model it after some of the systems that work very well, that have lots of independence and separate pieces.

So the way you might envision a star wars defense would be something like this. Rather than having one large centralized system with all the difficulties of getting that right, you might have dozens or even hundreds of separate pieces, each capable of tracking, each capable of targeting, each capable of shooting at and eventually destroying targets coming at the United States.

Now, each of those systems would be possibly different kinds of systems with different kinds of weapons and different kinds of sensors. They might be built by different contractors, different vendors, perhaps at different times, using different technology. The Russians would be faced, or anyone attacking us would be faced with something like a triad, but it now would be a many-legged defensive system.

If one of those battle groups had a software bug, had a flaw, had some misassumption about what a threat could do, it might misfire, it might fire at decoys instead of targets, it might not work. But an adversary attacking us would have to be convinced that not only that system would fail, but all of them would fail.

Now, if you take the analogy to the phone system, we all know that the phone system prides itself on great reliability. Yet we have all probably been out of service during certain unusual events. When I was at Yale University we were out of service for approximately 30 hours because somebody was digging a gas main line and they pulled up the main cable for all of New Haven. That was a very annoying situation. But on the other hand, the probability that simultaneously the entire United States would be without the phone service due to failures at all the switches across the country or even half the country would be out of service seems to be too much, to really think about.

And I think the fundamental problem that the critics have made is they have taken the straw man, they have taken this monolithic view. They talk about the system, and they give large numbers of lines of code estimates. They are right in that that will not work, but they are also wrong in that that is the only way to do the problem. And I think if we have any hope here to build a system of this sort, we need to move to this more distributed, independent structure.

There is one more very important advantage for this, and that is testability. Parnas says, I think in some of his papers, you may be able to build a system, it may even work, but you may have great trouble knowing that. Clearly, someone will have to testify in the future in front of such a panel trying to convince you that it works, and I think you will want very good proof of that.

It seems to me that if the system is composed of lots of separate pieces, you can get very good testing. You can put a little piece of the system up, test it exhaustively perhaps against live attacks that could be launched, gauge how well it works just like you would test a gun or even an ICBM, and see what its success rate is. After all, the critics believe that the current offensive systems work. No one has ever launched, and hopefully no one ever will launch a thousand ICBM's at once. Yet everybody is willing to believe that that system works, and the critical reason they believe it is that we have done single tests and they worked to some success, not perfectly, and they know that once those missiles are launched, they are all independent, they are operating separately. So if one fails or even if one type of missile fails, there are other kinds of missiles that will work.

So there is an independence argument that allows for testability, and I think that is, if you will, the fundamental mistake that is being made in the public debate on the software.

Senator WARNER. Dr. Lipton, we thank you.

Now, General Abrahamson, I am going to give you the opportunity to cross examine your three colleagues, if there was some fact they did not bring out that you would want as a part of this record, and feel free to use leading questions.

General ABRAHAMSON. Rather than cross examine them, I just would like to add several points.

I have indicated that I thought that the software problem and the entire combination of computer and data handling are really the long pole in the tent, and therefore, by the way, the least mature. But as I indicated earlier, it is an area of fundamental technical advantage in the west, and it is an area that we can and should exploit. and it makes sense in terms of being a foundation of the very kind of complete strategic defense that we are trying to build.

We are moving in the direction of a distributed software and command and control system, as these gentlemen have emphasized is so important. Our management plans are such that we have to have a centralized place where not just theories and architectural concepts will come together. Our management plans include that. That is the national ground test facility, and we will soon be going out on requests for proposals for large scale simulations which will be part of that. And then the second half, different concepts which will eventually nick down into the best architecture to be able to build such a thing in the future.

And I guess I believe that we are on the right course. And therefore, as I indicated to Senator Goldwater and to many others, I just flat reject the idea that this is impossible.

Senator WARNER. Thank you, gentlemen, and I thank the members of the panel.

Mr. Levin, do you have any questions of this panel?

Senator LEVIN. Just one question of all of them in terms of cost, as to whether they have any idea or any estimates of the cost of whatever software needs they envision for the SDI.

Mr. BROOKS. All the cost estimating methods used in our field start with knowing how many lines of code one must build and then tell you how many dollars and how many months it will take. The hardest part is guessing how many lines of code one must build. I have no basis for doing that in this case, nor have I seen anybody else's numbers in which I have any confidence, either.

Mr. LAU. Probably an important point is that it would be a small fraction of 1 percent of the total system cost. The cost is not the problem. Doing it is the problem.

Senator LEVIN. Of the software?

Mr. LAU. Yes.

Senator LEVIN. You say a small fraction of 1 percent of the total system?

Mr. LAU. Yes.

Senator LEVIN. Dr. Lipton, your decentralized system, do you have any idea of the cost?

Mr. LIPTON. The cost of the software part of it or the hardware?

Senator LEVIN. The software.

Mr. LIPTON. I think I would have to agree with what was just said. It is fairly hard to estimate it, but if most of the systems have software of the launches and the hardware, in a replication of hardware will dominate, I do agree with the general that the difficulty of the software may be one of the more difficult components.

Senator WARNER. Well, gentlemen, we thank you very much.

[Questions with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR JOHN W. WARNER

CRITERIA USED TO EVALUATE ABM TREATY IMPLICATIONS

Senator WARNER. The Department of Defense spelled out a number of criteria in this year's SDIO Report to the Congress were used to evaluate ABM Treaty implications for planned research experiments. Do you foresee any changes to these criteria?

Dr. IKLE. As noted in *Report to the Congress on the Strategic Defense Initiative*, 15 March 1985, the SDI program has been structured to be fully consistent with all U.S. treaty obligations, including the ABM Treaty. Currently programmed SDI activities were structured to be consistent with the previous, more restrictive interpretation of the Treaty. The President has determined that there is no need now to move beyond this interpretation, toward the boundaries of the interpretation the United States could observe while reserving the right to alter that policy in the future should circumstances warrant.

DEVELOPING AND DEPLOYING EFFECTIVE STRATEGIC DEFENSES

Senator WARNER. Would you share with the committee your vision of the offense-defense transition that would follow from a decision to develop and deploy effective strategic defenses?

Dr. IKLE. At this early stage it is premature to prescribe a particular transition to a balance of offensive and defensive forces. It would depend to a large extent on whether the Soviet Union had agreed to a cooperative transition or chose to be uncooperative. However, one possible transition could stem from the negotiations we are conducting with the Soviet Union in Geneva. It would involve major, equitable, and verifiable reductions in the offensive nuclear forces of the U.S. and Soviet Union. Such reductions which we seek even now in Geneva, could facilitate the eventual deployment of defensive forces by both sides, should such a decision be made.

ABM TREATY

Senator **Warner**. What factors compelled the timing of the administration's recent pronouncements on allowable activities under the ABM Treaty?

Dr. **Ikle**. Several factors led the administration to undertake a detailed review of the ABM Treaty text and negotiating record. These included Soviet violations of the ABM Treaty, ongoing arms negotiations at Geneva and the need to continuously review the SDI program to ensure its continued compliance with the ABM Treaty and other relevant U.S. treaty obligations. In addition, the administration in 1985 received detailed inquiries from the Congress about precise ABM Treaty constraints on the Strategic Defense Initiative. As a result of the detailed administration review of the ABM Treaty text and negotiating record, the President concluded that development and testing of ABM systems based on other physical principles is not prohibited by the ABM Treaty.

SDI DEFENSES

Senator **Warner**. Some administration spokesmen talk of SDI only in terms of thoroughly effective defenses, whereas others seem to leave open the door to a transition which passes through defense of particular assets, such as nuclear forces, on the way to more effective defenses. What is the administration's position with regard to defenses that fall short of the President's vision?

Dr. **Ikle**. The SDI program seeks a "thoroughly reliable" defense which will be capable of destroying ballistic missiles and their nuclear warheads irrespective of their targets. However, such a defense could not be deployed overnight. Realistically, any deployment of a defensive system in the future would have to be phased in. However, it is too soon to make any judgment about the particular characteristics of initial stages.

SDI TECHNOLOGY PROGRAM

Senator **Warner**. Can you provide for the committee an indication of how the allies might contribute to the SDI technology program, and what arrangements have been agreed to in this regard?

General **Abrahamson**. Initially, we formally contacted 18 of our Allies to determine interest in exploring possible cooperative efforts or contributions. These were Australia, Belgium, Canada, Denmark, England, The Federal Republic of Germany, France, Greece, Israel, Japan, South Korea, Luxemborg, the Netherlands, Norway, Portugal, Spain and Turkey. The result has been a series of continuing bilateral discussions with those interested countries to identify and agree upon areas of SDI research for possible participation.

An example of a potential Allied contribution is in the SDI Directed Energy Research Program. In this area, several of our Allies have ongoing, advanced programs involving laser and particle beam research which could complement efforts underway in the U.S. In the field of optics, specialized high quality materials and advanced construction techniques are areas of research expertise found in some of the Allied nations. There are some Allies who have extensive programs involving gallium arsenide research. Computer research, composite materials, electromagnetic launchers, and infrared sensors are just a few of the more general areas where Allied involvement could support our program of research.

There are three basic approaches for Allied involvement with SDI. The first would be creation of a government-to-government memoranda, the second a U.S. government-to-foreign industry contract with Allied entities as partners of subcontractors. Allies could also be invited to send selected, appropriately cleared, personnel to join specified U.S. research teams in science exchange.

To encourage participation, each of the aforementioned countries was invited to send a delegation of technical experts to Washington to receive a series of in-depth technical briefings from our staff on the concepts and progress of the program.

FUNDING REDUCTIONS

Senator **Warner**. You indicate in your statement that funding reductions have forced premature down selection of certain key technologies and that this will increase risk, delay schedules and increase costs. Can you be more specific about these adverse affects? Specifically, can you quantify them relative to the program that you first laid out to the subcommittee?

General **Abrahamson**. The example of ground-based, short wavelength laser technology is illustrative of our overall program difficulties. There are four competing technical approaches, two excimer and two free electron laser approaches. Due to fiscal constraints, SDIO has been forced to concentrate our efforts on a single free electron laser concept. Should the one approach we are pursuing prove technically infeasible, we would then have to resurrect another approach. Since our work in these other areas must now be confined to very low-level technology investigations, several years delay might result before we could reach our key decision milestone in the early 1990's. This problem extends to every single area of the SDI program.

PROGRAM OBJECTIVES

Senator **Warner**. One of the program objectives cited in your statement is to provide a basis for a full scale engineering decision in the early 1990's. Given current resource constraints, and the President's recent reaffirmation of his intent to comply with more restrictive ABM Treaty constraints, do you have a detailed program plan laid out that gets us from here to there, and specifically when does that plan support a full scale development decision?

General **Abrahamson**. The SDI Program aims for a full scale engineering development decision in the early 1990's. This decision point was planned and continues to be planned based on full compliance with the ABM Treaty. The impact of resource constraints has been to force us to prematurely narrow our technical options; this unfortunate fact leads to a higher risk approach, yet progress has been so rapid in several key areas that we remain confident that an informed and positive decision will be possible in the early 1990's.

ABM TREATY

Senator **Warner**. Would your following the more permissive interpretation of the ABM Treaty, which the administration appears to agree is justified, reduce the risk and cost of the program, and accelerate the point of decision?

General **Abrahamson**. The administration has always believed and continues to believe that informed decisions on the deployment of effective defenses can be made in full compliance with the ABM Treaty. Our understanding of the various interpretations of the treaty deals solely with what performance level is appropriate for our experiments. For those of us in the technical community, the differences in those performance levels have minor impact on our overall understanding of technical feasibility. The impact of performance levels which will be shown in the planned experiments is felt primarily in the confidence level of those outside the technical community that effective defense performance has been reached.

Senator **Warner**. What are you doing in the program specifically to protect the option of a near-term ABM deployment? Is such an option likely to be limited to terminal defense systems?

General **Abrahamson**. The SDI has as one of its major objectives, protecting our ability to respond to Soviet ABM treaty breakout with a defensive capability of our own. At this point in our system analyses, it is unclear whether the best response would be a so-called terminal defense system. Each technical element of the SDI, applicable to defenses in all phases of a ballistic missile's flight, has a major portion of its effort devoted to early use in a defensive system.

LASERS

Senator **Warner**. You cited considerable progress in free electron lasers and atmospheric compensation technologies. Have the space based segments of ground based lasers, for example, large mirrors, made corresponding progress?

General **Abrahamson**. We are making very rapid progress in all of the technical segments of ground based laser defensive options. While we have highlighted the spectacular progress of the laser device and the atmospheric compensation area, the other required technologies, such as large optical fabrication, pointing and tracking, large space structure technology are also progressing. We anticipate some very impressive hardware experiments in these areas in the near future.

STRATEGIC DEFENSES

Senator **Warner**. What is the strategic defense initiative organization doing with regard to the challenges that face strategic defenses against bomber and cruise missile threats?

General **Abrahamson**. We are working closely with those organizations charged with developing defenses against the so-called air-breathing threats. It is already apparent that much of our sensor technology will prove central to effective defenses against these threats. As part of our systems architecture studies we are addressing integrated defenses against all threats we face.

Questions Submitted by Senator Dan Quayle

SOVIET ABM SYSTEM

Senator **Quayle**. Our best intelligence estimates indicate that Krasnoyarsk is only one of several Soviet ABM efforts and that the USSR may be preparing a national ABM system that could defeat our bombers and submarine missiles' ability to retaliate against a Soviet first strike. If the Soviets could deploy a national ABM before the early 1990s (as DOD claims), how soon would we clearly know they were deploying such defenses and how soon could we have a national defense system deployed of our own?

Dr. **Ikle**. The Krasnoyarsk radar violations goes to the heart of the ABM Treaty. Large phased-array radars like that under construction near Krasnoyarsk were recognized during the ABM Treaty negotiations as the critical, long lead-time element of a nationwide ABM defense. The Krasnoyarsk radar thus appears especially menacing when considered in the context of other Soviet ABM-related activities. Together they cause concern that the Soviet Union may be preparing an ABM territorial defense. Some of these activities, such as the modernization of the Moscow ABM deployment area, are consistent with the ABM Treaty. Others involve potential or probable Soviet violations, including the apparent testing and development of components for a rapidly-deployable ABM system; this system is apparently designed to allow them to construct individual ABM sites.

In the event of such deployment, we would have extremely limited capability to match a Soviet ABM defense of its national territory in the near- to mid-term. Soviet deployment of an ABM territorial defense would have profound implications for Western security, eroding our deterrent and diminishing its credibility. Such a capability might encourage the Soviets to take increased risks in crises, thus degrading crisis stability.

Senator **Quayle**. Is it not the case that the Soviets rejected our efforts during the ABM Treaty negotiations to secure a ban against future ABM systems based on physical principles differing from those employed in ABM systems current in 1972?

Dr. **Ikle**. Although the U.S. delegation negotiating the ABM Treaty initially sought to ban development and testing of other than fixed land based systems or components based on future technology, the Soviets refused to go along, and no such agreement was reached. The Soviets stubbornly resisted U.S. attempts to adopt in the body of the Treaty any limits on such systems or components based on future technology. The farthest the Soviet were willing to go with respect to such future systems or components was to adopt a side agreement prohibiting only the deployment of such systems and components, once created, until the parties agreed on specific limitations.

COST OF SDI PLAN

Senator **Quayle**. Has SDIO even contracted for an analysis to be done or assigned someone within SDIO to study, full-time, how long it might take and how much money it might cost to complete a single SDI plan if it was decided that the United States needed a national missile defense system tomorrow?

General **Abrahamson**. Yes; this is one of the foremost objectives of the studies conducted in our architecture program.

SDIO SURVIVABILITY PROGRAM

Senator **Quayle**. If having survivable strategic command and control is critical to our ability to respond to a Soviet strategic attack, what programs, if any, is SDIO dedicating to defending these facilities?

General **Abrahamson**. As we proceed to greater understanding of system options, and as we develop the command and control for these systems, survivability is of utmost importance. We have a separate SDIO Survivability Program which is addressing the survivability issues for not only command and control elements but weapons and sensor elements as well. In addition, our architecture studies have been specifically tasked to provide options and answers to this most important question.

QUESTIONS SUBMITTED BY SENATOR CARL LEVIN

ABM TREATY INTERPRETATION

Senator LEVIN. Will you provide for the record copies of legal opinions justifying the recently announced broader interpretation of the ABM Treaty?

Dr. IKLE. Judge Sofaer, the Legal Advisor, U.S. Department of State, provided the administration's legal opinion regarding the less restrictive interpretation of the ABM Treaty in testimony before the Subcommittee on Arms Control, International Security and Science of the House Committee on Foreign Affairs. A copy of his statement is attached. (See Appendix, page 422.)

Senator LEVIN. Will you permit Members of Congress to read the negotiation record, parts of which you rely on for your conclusion that the broader interpretation of the ABM Treaty is the correct interpretation?

Dr. IKLE. Senator Warner and Hart have made a similar request and a separate response will be provided.

Senator LEVIN. Has the SDI office been formally notified of the new interpretation adopted by the administration? When? Please submit a copy of that notice.

Dr. IKLE. The SDIO participated in the discussion on this subject that took place prior to the President's decision and, of course, is aware of the President's decision. The Department of Defense, and therefore SDIO, consistent with the President's policy guidance, is governing its activities in accordance with the more restrictive interpretation of the Treaty.

Senator LEVIN. Does ACDA concur in the new interpretation? If so, is that concurrence in written form? Kindly furnish the committee a copy.

Dr. IKLE. All executive departments and agencies concur with the President's determination that the interpretation of the ABM Treaty which holds the ABM systems and components based on other physical principles may be developed and tested legally, is fully justified.

Senator LEVIN. Is there any ambiguity in the ABM Treaty as to what testing is allowed of space- or mobile-based components?

Dr. IKLE. The restrictive interpretation of the ABM Treaty, which we are following as a matter of policy, prohibits the testing of space-, air-, sea- or mobile land-based ABM components or devices capable of substituting for such components.

Under the broader, interpretation of our legal obligations under that Treaty, the above limits would apply, except in the case of devices "based on other physical principles." Agreed Statement D to the Treaty, which governs ABM systems based on other physical principles and devices capable of substituting for ABM components, places no limits on testing.

Senator LEVIN. If the Soviet Union accepts the new interpretation of the ABM Treaty and we, as a matter of policy, continue to adhere to the older, more restrictive interpretation, haven't we given the Soviet Union a significant legal and practical advantage in the unrestricted testing and development of new ABM systems?

Dr. IKLE. The United States and the Soviet Union have the same legal rights under the ABM Treaty. While the United States, as a matter of policy, has elected to conduct the SDI program in a manner consistent with the previous, more restrictive interpretation of the ABM Treaty, the President has reserved the right to adopt the broader and legally correct interpretation in the future if circumstances warrant. We can envision that in the future the day will come when we will have answered the questions necessary to permit us to consider going beyond the restrictions that we are observing under the current research program. At that time, based upon the strategic situation then faced by the U.S. and our allies and the actions of the Soviet Union in the interim, we will have the opportunity to reassess the need for change in present guidance.

BOOSTER SURVEILLANCE AND TRACKING SYSTEM

Senator LEVIN. Would devices in the Booster Surveillance and Tracking System experiment [BSTS], if proven feasible and if deployed and if they measure the signature of booster plumes in real time, be a violation of the ABM treaty?

General **Abrahamson**. It must be recognized that BSTS is an experiment and that we are still in the process of defining the exact nature of the experiment. As an experiment, BSTS will be fully compliant with all aspects of the ABM treaty. To speculate on the possible compliance of a deployed system based on technology being examined in an experiment which is not yet fully defined is not practical. [Deleted.] In any event, because the deployment of a nationwide defense against ballistic missiles is prohibited by the ABM Treaty, whether the deployment of a BSTS device would constitute a violation of the ABM Treaty as currently written is a moot point.

Senator **Levin**. Why are the experimental devices in BSTS not measuring booster plume signatures in real time? Is this an artificial limitation or a technology constraint?

General **Abrahamson**. The exact nature of the BSTS experiment is not yet fully determined. It is expected, however, that the experiment will include at least a limited capability to process some of the infrared focal plane data in or near real time. One of the key technologies being examined by this experiment is the capability to do real time processing. [Deleted.] In the final experimental design, the exact processing capability will be determined by the technology available to support the experiment and associated cost performance trade off analysis, as well as compliance with Treaty obligations.

Senator **Levin**. Can the BSTS experiment be made to process data in real time without significant additional research effort?

General **Abrahamson**. To the extent that technology is available in the time frame necessary, the experiment will process data in real time. As you know, significant advances are being made in the area of data processing. Due to the rapid change occurring in this area we do not believe it would be advisable to delay the experiment waiting on the development of more advanced processors. The technology which will be used in the experiment [deleted] will be adequate to allow us to project [deleted] what operational capability would be possible based on the more advanced hardware which would be available to support potential [deleted] deployment.

Senator **Levin**. Is the principal function of the BSTS experiment to demonstrate technology capable of upgrading the current satellite early warning system or is its principal function to permit a decision to be made on the applicability of more advanced technology for ABM purposes, or are they equally important purposes?

General **Abrahamson**. The BSTS has always had two distinct functions. The SDI effort is designed to examine the application of advanced technologies to detection and tracking in the boost phase. The Air Force has an ongoing requirement to perform Tactical Warning/Attack Assessment [TW/AA]. [Deleted.] We are coordinating our efforts in order to make the most efficient use of resources. An assignment of relative priority to these efforts is largely dependent upon your point-of-view. I believe it is reasonable to say that both are sufficiently important to justify continuation of the experiment.

SDI RESEARCH FUNDS

Senator **Levin**. Are we willing to set aside any SDI research funds for European firms? If so, how much?

General **Abrahamson**. No; we have not set aside specific SDI research funds for our Allies. On 26 March 1985, Secretary Weinberger formally invited our Allies to participate in the SDI research program. The willingness of foreign corporations to participate in SDI research has been impressive. Several Allied proposals are now under consideration and we fully anticipate awarding research contracts once potential contributions can be accurately assessed. However, until the full extent of technical participation can be determined, we are unable to estimate the required level of funding for Allied participation in the SDI.

Senator **Levin**. What discussions have you had with the Secretary of Defense or Deputy Secretary Taft regarding the usefulness of spending SDI dollars in Europe to help build a basis of support for the SDI program in Europe?

General **Abrahamson**. The decision to extend an invitation to our Allies was predicated upon the strengths of their technical capabilities. (Thus far, most of our Allies have indicated an interest in the SDI and have granted their corporations the right to bid on program contracts.) The Allied firms competing for SDI contracts will be evaluated on their (ability) capabilities to constructively contribute to the goals of the SDI. (Not because of the political climate in the region.)

Senator **Levin**. Have you had any discussions with Secretary Weinberger or with Deputy Secretary Taft regarding the usefulness of spending SDI dollars in any particular way geographically in the United States in order to help build a basis of support for the SDI program in the United States?

General **Abrahamson**. No; the SDIO will continue to maintain the policy of awarding research contracts based upon technical merit, not geographic locale.

Senator **Levin**. Are you going to make any contractual commitments in fiscal year 1986, or will the timing of the obligation of funds or outlay of funds in fiscal year 1986 require a higher level of funding in fiscal year 1987 to keep the SDI program going at the same level as was funded in the fiscal year 1986 budget?

General **Abrahamson**. It is anticipated that in fiscal year 1987 there will be a continuation of fiscal year 1986 efforts similar to the type experienced in fiscal year 1986 from fiscal year 1985.

At this time we do not know what the amount would be. Because the [CRA] Continuing Resolution Authority constrains SDIO to the fiscal year 1985 level we have not given the full go-ahead for fiscal year 1986. The impact on fiscal year 1987 cannot be addressed until the fiscal year 1986 program is distributed to the executing Services/Agencies.

COST OF SDI SYSTEM

Senator **Levin**. Do you have any estimate of the range of total cost of researching, developing and deploying an SDI system?

General **Abrahamson**. SDIO is currently investigating the technical feasibility and cost-effectiveness of potential SDI components and systems. It is still too early in the research phase to provide responsible cost estimates of the potential development and deployment of SDI systems. The research program has been estimated by SDIO and previously supplied to the Congress. As the research progresses and technical definition is increased, system cost estimates will be developed and refined.

Senator **Levin**. Has the SDI office been formally notified of the new interpretation adopted by the Administration? When? Please submit a copy of that notice.

General **Abrahamson**. Yes, the SDIO was notified of the administration's new position on the ABM Treaty. [Deleted.] As a result, we do not anticipate making any changes in the direction of our research programs. [Deleted.]

[The article referred to on page 53 follows:]

[From the Washington Post, Oct. 30, 1985]

Computer Bugs Seen as Fatal Flaw in "Star Wars"

(By Boyce Rensberger)

President Reagan's dream of an effective "Star Wars" system of antimissile defenses is almost certainly doomed to failure, according to a growing number of top computer programming experts who say there is no conceivable way to write and test the software that would be needed to operate it with adequate reliability.

Officials of the Strategic Defense Initiative, as the program is properly called, have long cited computer software—the programs that instruct computers how to operate—as their biggest single technical obstacle, but they insist that with enough time and money, it can be overcome.

Some argue that a high degree of reliability is not necessary—that less than-perfect reliability will be sufficient, since the Soviets would never have enough confidence to launch an attack against an America protected by Star Wars defenses, even if they knew there might be some bugs in the defense's computers.

Somewhat more tempered optimism is expressed by a panel of computer experts recruited to advise the Pentagon's SDI Organization (SDIO). Some members concede that while it is impossible to eliminate software bugs that could make the hardware malfunction, it may be possible to design systems that quickly isolate malfunctioning components, limiting the damage they can do. Others hold simply that SDI is a research program in its early stages, and that it is too soon to say it can't be done.

Outside SDIO, on the other hand, leading software engineers are mostly pessimistic. They say SDI officials underestimate the difficulty of the software problem and over-estimate the capabilities of software engineering. Many say flatly that SDI's goals are impossible to achieve given the current state of the software writing art and that no foreseeable advance within this century will change that.

While lasers and other beam weapons have dominated much of the public perception of the technical side of SDI, relatively little popular attention has focused on the fact that the entire system would have to operate completely automatically, under the control of a network of computer programs that would, all sides agree, comprise the longest, most complex piece of software ever created.

Because the Star Wars system would have to respond so fast and be so highly effective, there would be no time for human intervention, no time even to "wake the president," as one SDI official put it, before committing the United States to war.

The first engagement of a nuclear war—and perhaps the last—would have to be entirely under the control of a computer programmed in advance on the basis of assumptions about how the Soviets would attack and how the United States should respond.

Computers linked to orbiting sensors would have to be the first to detect an attack. Computers would have to discriminate between thousands of real weapons and tens of thousands of decoys meant to waste U.S. firepower. Computers would have to calculate the trajectories of all objects in the "threat cloud." Computers would have to determine the nature of the attack and select an appropriate strategy for responding, selecting the highest priority targets and assigning them to orbiting battle stations armed with lasers or other weapons. Computers would have to aim the weapons. Computers would have to verify that Soviet missiles and warheads had been destroyed. And the computers could not "go down" if the Soviets happened to blow up a hydrogen bomb in their vicinity.

In a matter of seconds or, at most, a few minutes, an antimissile system of the sort envisioned by President Reagan and SDI officials would have to make all the decisions that in a conventional war would be made by legions of reconnaissance experts, field commanders, generals, the Joint Chiefs of Staff and the commander-in-chief over a period of days, weeks and months.

People just don't seem to understand that software isn't like most other engineering problems. There are some fundamental reasons why it can never be made reliable enough that you could have confidence Star Wars would really work," said David L. Parnas, one of the computer worlds' most respected authorities on large-scale programming. Parnas, a U.S. citizen, is a professor at the University of Victoria in British Columbia. "I'm not saying it's impossible. I'm saying you'll never know how reliable it is."

One reason for this uncertainty, SDI opponents say, is that it will not be possible to test the entire system under realistic conditions. Computer programs invariable contain errors, or bugs that can be found only by debugging—running the program, trying to make it perform as intended, seeing where it goes wrong, rewriting the erroneous code and rerunning the program.

SDI advocates say it would not be necessary to test the software of a defensive system under realistic conditions, because programs can be debugged by running them on simulators.

Last June, Parnas was appointed by SDIO to its advisory committee or "battle management software." Parnas, who says he supports Reagan's goal of eliminating the threat of nuclear weapons and who has worked on military aircraft computing problems for many years, attended the panel's first session.

After meeting the other members and hearing SDIO's expectations, he quit in frustration.

"In March 1983," Parnas wrote in his letter of resignation, "the president asked us, as members of the scientific community, to provide the means of rendering nuclear weapons impotent and obsolete. I believe that it is our duty as scientists and engineers to reply that we have no technological magic that will accomplish that."

Parnas' resignation, accompanied by eight technical papers that he said explained why the software could not work as desired, galvanized the software engineering comunity and set the terms of a debate that continues to rage on campuses, where more and more software specialists are declaring their skepticism. The debate has become a prime topic on certain electronic "bulletin boards," by which many computer professionals communicate.

"I do believe, with Parnas and many others, that the software required simply cannot be produced to the degree of confidence without which it would be a meaningless exercise," Joseph Weizenbaum, a computer expert at the Massachusetts Institute of Technology, told his colleagues via the bulletin board."

"If the physics of the problem permits a good antimissile defense," countered John McCarthy of Stanford University's artificial-intelligence program, "the programs can be written and verified. However, it will be quite difficult and require dedicated work."

Larry Smarr, head of a new federally funded National Center for Supercomputing Applications at the University of Illinois, is among hundreds of physicists and growing numbers of other scientists-including software engineers—who have signed a petition refusing to work on SDI research because of its technical dubiousness.

"In my experience as a physicist who has written some pretty large computer codes." Smarr said, there is no way you could produce a code large enough to handle the job and do it perfectly the first time, which is what you would need. I can't imagine any developments in computer technology that would make it possible in the foreseeable future."

It is generally agreed that the software required for the Star Wars system would consist of at least 10 million lines of code, though some say it would be nearer 100 million. A line of code is an instruction, written in a programming language, telling the computer to carry out one in a series of data processing steps.

SDI advocates note that the space shuttle uses about 3 million lines of code, including the computers on the ground that control the launch and that control the flight from Houston, in the shuttle itself are about 100,000 lines.

"This is software that's evolved over many years of the space program. It's been tested on the ground many, many times. It's flown the shuttle successfully many times and yet we still have shuttle launches aborted because of software failures." Parnas said, "What happened is that in all the tests they never encountered the exact set of circumstances that revealed a bug that was in there all along.

"The SDI people say they will test all their software before deploying it, but what if they don't anticipate the exact set of circumstances that the software will encounter somewhere down the road when the Soviets decide to attack? You can't go back and fix the bug and start the nuclear war all over again."

Computer specialists know that all programs, even ones sold for commercial use, contain bugs—many of which are not discovered until years later.

Parnas said it is not unusual for debugging to continue long after new computerized weapons are deployed in the field. "Programmers are transported by helicopter to Navy ships. Debugging notes can be found on the walls of trucks carrying computers that were used in Vietnam," Parnas said, "it is only through such modification that software becomes reliable. Such opportunities will not be available in the 30-minute war to be fought by a strategic defense battle management system.

"The largest program I ever saw that was correct the first time it was run was five lines," Parnas said.

The reason computer programming is so hard is that a human mind must think through every function the computer must perform and break the task down into a complete and flawlessy logical set of small steps. At each step where alternative outcomes are possible, the programmer must anticipate each one and add to the program a full and flawlessly logical set of instructions on now to deal with each of these outcomes.

SDI's programs would be stored in digital form in several places, some in ground-based computers and some in computers aboard orbiting platforms carrying sensors or beam weapons. The components would communicate by radio—sending, for example, information on an enemy warhead's position from a sensor to a laser platform.

For every stage, or layer in the sequence of steps, at which alternative outcomes can occur, the program's complexity multiplies. Like a tree whose trunk divides repeatedly into tens of thousands of branch tips, the sequence of steps a program executes can lead to any of several thousand alternative outcomes. Unlike a tree, computer programs also contain many "branches" that emerge from one "limb" only to arch sideways, reentering some other branch.

Programmers say it is impossible to keep all the pathways clearly in mind so that the rules of programming logic are not violated are not violated and that every branch is always prepared to deal properly with the data that may enter it from all other connected branches.

As programmers like to say, their software usually does exactly what they tell it to do, not what they want it to do.

Typical programs for word processing or spreadsheet analysis, usually no more than a few hundred lines long, contain scores or even hundreds of bugs when first written. Only repeated use, trying out every conceivable combination of maneuvers, can reveal the bugs. Bugs remain even after most software is put on the market—a situation that causes most manufacturers not only to deny their customers a warranty but to print a specific disclaimer of warranty.

For example, IBM's disk operating system software, the program without which no other program will run on an IBM-PC, carriers the follwing disclaimer: "The program is provided 'as is' without warranty of any kind, either expressed or implied . . . . The entire risk as to the quality and performance of the program is with you. Should the program prove defective, you (and not IBM or an authorized personal computer dealer) assume the entire cost of all necessary servicing, repair or correction."

Top software engineers say bugs are not an indication of careless programming but a fact of life that even the best programmers must cope with. Morever, they note, as programs grow larger, the incidence of bugs increases not in proportion, but much faster.

"You talk to people who write these big programs," Parnas said, "and you think you're talking to sociologists. They'll tell you that when they run their program it does 'funny things' that they can't predict. 'Sometimes it does this; sometimes it does that,' It's like they're trying to predict public opinion. You ask them what their program will do in such and such a situation and they say. 'I don't know. Let's try it.' "

SDIO's panel on computing, while conceding some of Parnas' points, insists that these concerns are not fatal to the long-range goal. "Perfection is a bit overrated." said panel chairman Danny Cohen of the University of Southern California. "There will always be hugs and malfunctions. But that doesn't mean the thing won't work. You can design the software so that when bugs turn up. They are isolated in the system. You design the system to cope with malfunctions.

"Parnas keeps talking as if there is some fundamental law of nature that says it's impossible. But there isn't. This is not like perpetual motion, where you can show mathematically that it's impossible. It will be very hard to produce this software but as long as it isn't like perpetual motion, it isn't impossible."

A different problem for SDI software, according to the critics, lies in the fact that the program must embody assumptions about the characteristics of Soviet weapons.

For example, when a swarm of warheads is hurtling over the Arctic toward the United States, they are likely to be surrounded by perhaps 10 times as many decoys—objects designed to look like real warheads to the sensor. If the sensors cannot tell them apart, the beam weapons will have to spend precious time and energy destroying every object. If there are enough decoys, the beam weapons will not have time to destroy all the threatening objects and some warheads will slip through.

If the sensors and their computers are to distinguish the decoys, they must first be programmed to do so. "Unless the Soviets cooperate and tell us what characteristics to look for, the recognition algorithms written into the software could be wrong," Parnas said.

"If [the Soviets] come up with just one special trick to spoof the system and our people didn't happen to design the system to cope with that, it won't work," Smarr said. "It's going to be a Maginot Line in space."

"Parnas is putting his finger on some real technical problems," said Charles Seitz, a computer panel member from California Institute of Technology, "but these are things that SDI is researching. While Parnas is going around debating, we're studying the problems. The honest answer right now is that there is nothing today that assures us it can be done or that it can't be done. Existing software engineering practice has never encountered a problem quite like this before."

For all its optimism, the computer panel has concluded that there are limits to what software can do. The way out, as Seitz and Cohen described the panel's findings, is to rethink the nature of the hardware being considered for an antimissile system, limiting it to something that software could handle. In a formal report being prepared for SDIO, Seitz said, the panel will be "quite critical of the system architecture," the general configuration of the system's hardware that SDIO has been considering.

One change under consideration in the "system architecture" is decentralizing the battle management functions so that each orbiting battle station operates with some autonomy, said Air Force Maj. David Audley of SDIO's computer section.

"Instead of having the whole system operated by one monolithic computer," Audley said, "we're thinking now about a loose federation of battle stations."

Audley said software limitations may force acceptance of a less efficient battle management. As a result, for example, a Star Wars system might end up with two or more battle stations shooting at the same target.

Critics say that while decentralization can overcome some barriers, each semiautonomous software module would still suffer from a lack of debugging under realistic conditions. Also, any bugs or wrong assumptions programmed into one module would be present in all.

For all their pessimism, most critics concede that if the government keeps spending money on SDI, someday there will be a huge computer program that SDIO calls battle management software. "But this software will not have the reliability that you or I would consider to be essential for such a system," said James J. Horning of Digital Systems Research Center in Palo Alto, Calif. "Nor will it be possible to retrofit reliability into it. The country will be faced with a cruel dilemma: deploy a system that cannot be trusted, or scrap it."

Senator **Warner**. The hearing is now recessed. The record will stay open, and I think the hearing was a very successful one.

[Whereupon, at 12:45 p.m., the subcommittee recessed, subject to the call of the Chair.]

STRATEGIC DEFENSE INITIATIVE

WEDNESDAY, NOVEMBER 6, 1985

U.S. SENATE,
SUBCOMMITTEE ON STRATEGIC AND
THEATER NUCLEAR FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

POLICY AND TECHNOLOGY OBJECTIVES

The subcommittee met in executive session, pursuant to notice, at 9:06 a.m., in room SR-222, Russell Senate Office Building, Senator John W. Warner (chairman) presiding.

Present: Senators Warner, Goldwater, Thurmond, Quayle, Wilson, Nunn, Hart, Exon, Levin, Bingaman, and Glenn.

Also present: Senators Wallop and Gore.

Staff present: James F. McGovern staff director and chief counsel; Arnold L. Punaro, staff director for the minority; Jeffrey H. Smith, minority counsel; Robert G. Bell, Robert F. Bott, Douglas R. Graham, William E. Hoehn, Jr., George K. Johnson, Jr., Gordon G. Riggle, and Carl M. Smith, professional staff members; Colleen M. Getz and Russell C. Miller, research assistants; and Karen A. Love, staff assistant.

Also present: James M. Bodner, assistant to Senator Cohen; Henry D. Sokolski, assistant to Senator Quayle; Mark J. Albrecht, assistant to Senator Wilson; Allan W. Cameron, assistant to Senator Denton; Alan Ptak, assistant to Senator Gramm; Janne E. Nolan, assistant to Senator Hart; Jeffrey B. Subko, assistant to Senator Exon; John B. Keeley, assistant to Senator Levin; Edward McGaffigan, Jr., assistant to Senator Bingaman; and Milton D. Beach, assistant to Senator Glenn.

OPENING STATEMENT BY SENATOR JOHN W. WARNER, CHAIRMAN

Senator WARNER. The subcommittee meets in executive session this morning to continue receiving testimony from administration officials on the President's Strategic Defense Initiative [SDI].

This is the second of five hearings currently planned by the subcommittee on this important program. Next Tuesday morning, the subcommittee will be briefed by representatives from the intelligence community on Soviet strategic defense programs.

Last Wednesday, the subcommittee received testimony in open session regarding the policy and technology objectives of the SDI Program. Today, we will continue with this testimony, as well as receive testimony on the system architecture options that have been developed by the SDI Program.

Our witnesses this morning are Hon. Richard Perle, the Assistant Secretary of Defense for International Security Policy, and Lt. Gen. James Abrahamson, the Director of the Strategic Defense Initiative Organization [SDIO]. General Abrahamson is accompanied by John Gardner, the Director of Systems for the SDIO. I would like to welcome our witnesses this morning.

After the opening comments of my colleague from Colorado, Senator Hart, we will proceed with Mr. Perle's testimony. This will be followed by a brief round of questions for Mr. Perle, with each member limited to 5 minutes.

Then, General Abrahamson, I invite you to elaborate on any issues that you felt constrained to discuss in last week's open session. We can then proceed with Mr. Gardner's presentation.

Senator Hart.

Senator **Hart**. Thank you, Mr. Chairman.

Our last session left very much in doubt the question of the administration's interpretation of what the ABM Treaty does and does not permit. Even though much of what we will hear this morning will continue to be technical and technological in nature, we must remember this committee is tasked with overseeing not only technological developments, but policy developments, as well.

So, we still confront the problem of the administration's position on ABM and what is permitted and what is not.

Since our last hearing, there have been several remarkable developments.

First was the President's so-called open labs proposal which caught many Members of the Congress off guard, as well as the public at large.

I think it is fortunate that we have Mr. Perle here to tell us what that means and how that is going to be implemented.

Second, was the statement by the President to Izvestia that the SDI system would be deployed only after reaching an agreement with the Soviet Union eliminating offensive weapons on both sides.

It is my understanding that there is a news account this morning in which the White House Press Corps attempts to state that is not really what the President meant after all.

Finally, there is Secretary Weinberger's testimony before the Senate Foreign Relations Committee in which he said SDI would be deployed even if it were not cost effective at the margin, which I understand to be almost a total policy departure from everything we have heard previously from virtually everybody in the administration.

While we are here to continue to hear General Abrahamson discuss the technological evolution of the SDI system I for one will want to pursue those topics with any of the witnesses who will want to respond for the administration.

Thank you, Mr. Chairman.

Senator **Warner**. Senator Wilson.

Senator **Wilson**. Mr. Chairman, I commend you and Senator Hart for convening this set of hearings. I think they are essential. I think the timing is superb.

I will not take more time. I am delighted that our colleague, Senator Wallop, is here. He shares a keen interest and I thank you for the courtesy extended him.

Senator **Warner**. You are all welcome.

Mr. Wallop, do you have a statement you would like to make?

Senator **Wallop**. No. I wish to express my appreciation for being allowed to sit in here.

Senator **Warner**. Senator Gore.

Senator **Gore**. Ditto.

Senator **Warner**. Mr. Perle.

STATEMENT OF HON. RICHARD N. PERLE, ASSISTANT SECRETARY OF DEFENSE (INTERNATIONAL SECURITY POLICY)

Mr. **Perle**. Thank you very much.

Forgive me for not having a prepared statement. What I would like to do in a few words is make a couple of points and perhaps comment as well, briefly, on the questions that Senator Hart has raised. I do not think we have seen the last of the remarkable developments that are likely to take place between now and the summit in Geneva.

The first point I would like to make is that the Soviets have had for some time and will continue to have an aggressive program aimed at strategic defense of all types, defense against bombers, defense against submarines and defense against ballistic missiles.

In the latter case the Soviets are moving aggressively with systems of the classical type, the sorts that were envisioned at the time the ABM Treaty was signed in 1972. They continue to make a substantial investment in the Moscow ABM system which is intended to be improved and upgraded. It now resembles the concept for the classical defense we had in mind in 1972 and it has gone beyond that.

In addition, there are serious questions, about which it is not now possible to be definitive, as to whether the Soviets are even now in the early stages of breaking out or creeping out of the ABM Treaty.

By deploying the necessary national infrastructure of large phased array radars, by having developed components, small radars and interceptors that could be quickly deployed, the Soviets have raised the prospect that the leadtime we anticipated before such a development could take place—a leadtime paced by the 5 to 7 years it takes to build a large radar infrastructure—may be shrinking to near the vanishing point.

I say it is not possible to be definitive because we see only early developments with respect to some of these Soviet activities. But I think it is possible to say, even now, that one can no longer be sure that we will not see the sudden emergence of a Soviet territorial defense.

The Soviets have a doctrine that supports the concept of strategic defenses, a doctrine that has never changed. It was adopted before the ABM Treaty, and it has persisted since the ABM Treaty.

It is associated with an awesome buildup of offensive forces. I think it is fair to summarize Soviet policy this way. They anticipate attacking U.S. retaliatory systems with their offensive forces and absorbing as much as they can of our retaliatory response which would be made with significant but degraded capability, using a variety of defenses at their disposal.

The debate on whether to proceed with the SDI reminds me of an earlier debate, a debate in the 1950's over whether the United States should proceed to build the hydrogen bomb. As in that debate, the scientific and technical community is divided.

Indeed, one of the participants in that debate is a participant in the current debate over SDI, Dr. Edward Teller. As I recall, it was Edward Teller's view that we ought to proceed with the development of the hydrogen bomb. He believed that the Soviets would do so whether we did or not and if we did not proceed the Soviets would emerge with a monopoly of thermonuclear weapons.

Robert Oppenheimer and most of the scientific community, took the opposite view, that we ought not to proceed, that if we did so the Soviets would surely follow suit and the world would be worse off.

We now know that even as that debate was taking place, as President Truman was listening to the arguments of the Teller camp and Oppenheimer camp, Andrei Sakharov had been inducted in the Soviet program to develop the hydrogen bomb.

Indeed, he went to work on that program before President Truman made the decision to proceed with ours. Had Oppenheimer prevailed over Ed Teller we would have faced in the 1950's a Soviet monopoly in thermonuclear weapons and I leave it to the members of the committee to imagine the consequences of such a development.

I think we are in a similar situation with respect to strategic defenses. The Soviets will go forward independent of what we do. The risk of not going forward ourselves is the prospect that the Soviets will emerge with a monopoly of strategic defenses.

I believe that the deployment of strategic defense can greatly reinforce deterrence by diminishing the prospects that a Soviet strike against this country could succeed in sufficiently degrading our forces so that facing massive Soviet reserve forces and some substantial Soviet defense capability, we would be deterred from retaliating.

I think it is likely to be the case that a first generation SDI, whether it proves to be capable of defending the population or not, it would greatly improve the credibility of our deterrent, and I think it is worth pursuing for that reason alone.

If it leads ultimately to the sort of defense that is part of the President's long-term vision, so much the better, but I think one need not assume that in order to justify carrying on with our program.

It seems to me the alternative to moving in the direction of a strategic posture based on a greater reliance on defense is to continue to compete with the Soviet Union in the offensive area. I believe that is an area where the Soviets hold all of the significant advantages. They do not have a protest movement that makes it politically difficult to deploy new offensive weapons. They do not run the risks associated with mobile systems because they have a population that they can count upon to permit the deployment of those systems wherever the leadership may choose. They do not have terrorists to worry about on Soviet territory and they have a prodigious quantity of land on which they can deploy offensive weapons.

We suffer disadvantages in every area where the Soviets possess advantages. It seems to me foolish to compete with the Soviet Union in an area where they are strong and we are weak.

It makes a great deal of sense to compete in an area where we are strong and we hope they will prove to be weak, and that area of our great strength is the technological base on which we are building and attempting to bring the SDI to fruition.

Finally, let me say a word about the interpretation of the ABM Treaty. It may strike you as remarkable—it struck me as remarkable—that in the dozen or so years after the ABM Treaty was signed in 1972, largely because there was no U.S. strategic defense and, therefore, the issue was not forced to the surface, the executive branch in successive administrations did little or nothing to look back to the treaty and the record of those negotiations to determine whether statements made at the time of the treaty in 1972 about what the treaty provided were in fact correct and supported by the negotiating record.

Call it carelessness or inattention, if you like, that would not be unfair; it was shared by many administrations. Owing to questions put to the executive branch by this committee, particularly by Senator Levin, we went back and took a hard look at precisely what the treaty provided.

As you know, a great many statements have been made that build upon earlier statements without independent corroboration. Some of the statements made about what the treaty entailed were made by this administration which did not do its homework.

In responding to the very specific question put by Senator Levin to Dr. Hicks at his confirmation hearing, we found it necessary to go back and look at the treaty because in the interagency review process so many people held different views as to what the treaty provided.

We were all presumably reading the same treaty. I asked a young Defense Department lawyer, who recently came to the Department of Defense from another agency of the Government, who was unfamiliar with the history of the interpretation of the ABM Treaty and who could be counted upon to take a fresh look, to review the treaty and the negotiating record and report to us his view of the interpretation of many terms which had been used, sometimes loosely, by successive administrations—terms like prototype, subprototype, breadboard model—the sorts of terms about which we were questioned by Senator Levin.

I was struck to discover that most of the terminology the Senator referred to, and we were asked to comment upon, appeared nowhere in the treaty and in some cases not even in the negotiating record. It was as though we had been having a conversation with ourselves about what the treaty meant independent of what the Soviets had said to us or what we had said to them during the course of the negotiation.

A young Defense Department lawyer prepared a paper that came to a conclusion that seemed startling at the time, but which is not now, in retrospect. That is that the 2½ years of negotiation of the

ABM Treaty entailed an effort by the United States to persuade the Soviet Union to abandon not only the defenses that were then available, but the prospect of future defenses as well; that the Soviets had resisted to the end any such sweeping prohibition, in particular with respect to research, development and testing.

The final result of that difference was expressed in an agreed statement, a part of the treaty, that envisioned the creation of ABM systems and their components based on other physical principles, physical principles not understood at the time.

Over and over again, when one goes back and looks at the negotiating record, one finds the Soviets saying, sometimes in exasperation, "How can we agree to limit things we cannot even define? We cannot do that and we will not do that."

In the end the agreed statement bridged the differences between us by banning deployment but permitting research, development and testing of defensive systems based on other physical principles.

On this, I believe the treaty is clear.

Now, as you might imagine, there were others in the Government who had coasted for years on the strength of the reputation of the earlier interpretation to which I referred who were taken back by this new interpretation.

They did the normal thing in such circumstances; they went to their lawyer for a second opinion. Their lawyer in this case was the new legal adviser to the Department of State, the distinguished circuit court judge, Abraham Sofaer, who, like the young Defense Department lawyer, was unfamiliar with the negotiations and could, therefore, examine the treaty and record with a fresh eye.

To the astonishment of my colleagues across the river in the State Department, the State Department legal adviser came essentially to the same conclusion that Phil Kunsberg had come to in this research.

So, the administration did the only thing available to it, in my judgment, having become aware that we had for years misstated the agreement reached between the United States and the Soviet Union. Anxious not to continue, with the knowledge it then possessed, to misstate the obligation between us, it adopted as a matter of law and legal entitlement the only interpretation that it at that point considered to be valid.

As a matter of policy, the President has indicated that we will respect the narrow and wrong interpretation of the treaty because our program has been configured with that interpretation in mind and the issue for now is, therefore, moot, as to which interpretation applies.

As a matter of law and entitlement, it is the view of the administration that agreed statements clearly envision and permits research, development and testing of ABM systems or their components based on other physical principles.

The only prohibition, and even this is technically arguable, but the only prohibition we are prepared to accept as legal requirement under the ABM Treaty is prohibition on deployment, except pursuant to the amending procedures and the consultative procedures laid down in the treaty.

Finally, a word or two about questions raised by Senator Hart.

I think the open labs proposal attempts to get at that minimum level of confidence that we need if we are going to negotiate arms control agreements with the Soviet Union, any arms control agreement with the Soviet Union, because as we sit here, it is still the official policy of the Soviet Union that it has no SDI program; and we know that to be a lie.

How we can hope to negotiate agreements with a negotiating partner across the table who refuses to acknowledge a multibillion dollar program that reaches back into the 1960's and that they are aggressively pursuing, is beyond me.

So, the President has proposed that the Soviets drop that pretense and he has invited the Soviets to participate in exchange visits to labs so that we can once and for all clarify that the Soviet Union does indeed have a program and a very vigorous one.

Senator THURMOND. The President has done what now?

Mr. PERLE. He has proposed that the United States and the Soviet Union permit exchange visits to each other's labs so that we can at the very least settle for once and for all the fact that the Soviets have a sizable strategic research defense program of their own, something they have officially denied right up to the present.

Senator THURMOND. He will pass that recommendation on to them?

Mr. PERLE. That is correct.

With respect to the circumstances under which we would or would not deploy a strategic defense——

Senator HART. Are you going to require security clearances for these Soviet scientists to get into Livermore and places like that?

Mr. PERLE. I think we have procedures for one-time exceptions to the normal security rule. Obviously, what has been proposed is a broad concept. We would not implement such a proposal in a manner that is prejudicial to our security.

There is a great deal to be discussed, both with the Soviets and to be arranged internally before the visit takes place. I do not see how we can negotiate with a partner who denies—

Senator HART. That is a separate question, whether the Soviets wish to negotiate.

I am asking a mechanical question about throwing open the gates of Livermore lab, letting them bring a hundred scientists over.

Mr. PERLE. No. I think this clearly has to be a matter of negotiation as to what facilities and under what circumstances. We will insist on a degree of reciprocity that would make it worthwhile from our point of view.

Senator WARNER. Please continue with your direct testimony.

Mr. PERLE. With respect to the circumstances under which we would deploy a strategic defense, the President has said on many occasions that that is a decision, a deployment decision, which is one that we would discuss with our allies, and with the Soviets, but that it would not give the Soviet Union a veto over American deployment.

The Senate did not give the Soviets a veto when it ratified the ABM Treaty and I think it would be both unwise and consitutionally unsound for this or any other President to do so.

Finally, a word about Secretary Weinberger's remarks and this question of cost effectiveness at the margin. It is one of many criteria. It is a criterion that is firmly embedded in the thinking of many of us who went through the debate on the deployment of ABM systems of the classical sort in the early 1970's.

It seemed to us then that if the Soviets could simply add reentry vehicles at a cost significantly lower than the cost of adding interceptors, that it would be unwise to deploy a system in which that was the case.

We are now looking at quite different approaches to defense, approaches in which there is not a one-to-one relationship between interceptors and reentry vehicles. It is not clear to me that one should be mechanistic in applying the principle of cost effectiveness at the margin.

I believe what Secretary Weinberger has been saying is that it would be foolish for us not to deploy a strategic defense if our calculations showed that it cost us a bit more to defend against an RV than it costs the Soviets to produce an RV.

Senator HART. That RV can have penetration aids?

Mr. PERLE. Yes, the whole array of hardware necessary to overcome the defense. The point at which it becomes a foolish proposition cannot be anticipated now.

Clearly, we would not deploy a $100 billion defense that could be overwhelmed by a $10 billion offense.

On the other hand, it is far from clear that it would be unwise for us to deploy a $100 billion defense that could be overcome by a $120 billion or an $80 billion offense because that $80 billion offense might well come at the expense of a variety of other equally or more menacing Soviet developments.

So, I don't think one can be mechanistic about this.

Mr. Chairman, that is all I wish to say.

Senator WARNER. We will proceed with a round of questioning for 5 minutes by each member. We will invite our guests to participate in questions at the conclusion of the questions by all members of the subcommittee.

Mr. Perle, the President in discussions about Geneva raised the proposal by this country to have both sides abandon the mobile ICBM. For some time now the Congress of the United States has been working on the President's strategic force modernization program under the framework laid down by the Scowcroft Commission.

Will you address the Scowcroft Commission report, what is left of it, and should this proposal be banned in Geneva?

Mr. PERLE. The question of what is left of the Scowcroft Commission report has occurred to some of us, as we watched the MX development cut back from 100 missiles to 50 missiles.

I think I ought to be candid about this, although it was not an element in the decision to propose the banning of mobile missiles.

Senator WARNER. I missed your point. It was not what?

Mr. PERLE. It was not an element of the decision to propose to the Soviets that we ban mobile missiles.

If faith has been broken with the Scowcroft Commission, it has been broken in the scaling back of the MX program. As I understood the understanding that was reached at the time of the Scowcroft Commission report, the administration accepted the report in its totality, although there were points in it about which we had reservations, on the understanding that it was also accepted by the Congress in its totality, although there were points about which the Congress was not in full agreement.

I believe that was the understanding reached at the time. Here we are in 1985, with only one-half of the MX program, maybe, and it seems clear to me that the departure from the Scowcroft Commission understanding began in Congress and not in the executive branch.

I want to say a word about why we think it is in our security interest to propose banning mobile ICBM's. There are several reasons.

The first is that the Soviets have them and we do not. While there is, in a number of places in the Congress today, an enthusiasm for the development of the Midgetman, our experience has shown that you cannot anticipate what future Congresses will decide with respect to a weapons system like this.

It is one thing to have a mobile missile in the abstract and quite another to put it down in someone's State, as we have discovered in the past.

I do not think that anyone will argue that the future of the Midgetman is assured either from a technical or budgetary or political point of view.

While we continue to develop it and hope and expect it will be possible to bring it to fruition in the absence of an arms control treaty banning it, there is no certainty about it.

There is enormous certainty about the Soviet's mobile missile program. One is deployed, the other is about to be deployed. We believe there are follow-ons to both the SS-24 and SS-25 and, in my view, we face over the long term a very sizable, perhaps a massive, Soviet deployment of mobile missiles.

Now, just a few years ago it was generally understood, and particularly by those who were more enthusiastic about arms control than I am, that you cannot verify mobile missiles in a number of important respects. You certainly cannot tell how many have been produced and it is not even clear how you can tell how many are actually deployed.

The Soviets with their current mobile missile, the SS-20, have made it easy for us by associating those missiles with large fixed installations, so we are able to count the minimum number of SS-20's.

There is no reason why they have to associate those missiles with large observable fixed installations. The prospect exists and will continue that in the absence of a ban on missiles, they could have many more than the treaty limitation will provide for.

So, we are particularly vulnerable to Soviet cheating with respect to mobile missiles, and the record of Soviet cheating in areas where they must have known they would be observed has alarmed and concerned us about the prospects that they will show the restraint necessary to comply with the agreement.

So, for all of those reasons we think it is good for the United States if mobile missiles are banned on both sides.

Senator **WARNER**. Mr. Perle, I think most of those reasons were well known to the administration with the exception of the action of the Congress on MX, well known to the administration at the time the whole mobile concept of Midgetman was proposed.

Turning to a different subject and that is you said the negotiating record, and I may not have the exact verbatim, indicates the Soviets stated, "How can we define things we do not even know about?"

Mr. **PERLE**. "How can we ban things we cannot even define?"

Senator **WARNER**. That is the record that is in the exclusive jurisdiction of the executive branch and, therefore, we are asked to accept your representation and the representation of other administrations' officials at face value without benefit of an independent examination by the Congress.

Is that correct?

Mr. **PERLE**. I don't want to make policy on the issue. I think it has been generally the case in the past that details of the negotiating record have been held by the executive branch.

Senator **WARNER**. The repeated assertions by the Soviets, how can we ban things we cannot define, is found in that portion of the record.

Mr. **PERLE**. That is correct, and reinforced by public statements made at the time.

Senator **WARNER**. Turning to a third point, and my time is up, you used the phrase, "In connection with the open labs' minimum confidence level."

Would that be a euphemism for partial trust?

Mr. **PERLE**. Yes, it would. I think partial trust would be a euphemism, too. The truth is we are sitting opposite these fellows and they deny they have an SDI program.

Obviously, we stay at the table and continue to negotiate despite that because we know they know we know it is not so. But at some point it seems to me it would be worth getting it on a permanent footing by an exchange of scientists.

Senator **WARNER**. You think that would be provided by some ability to exchange scientists in and out of labs. The problem we have in Congress is gaining public support. The public is concerned about the United States leaking one way or another too much information to the Soviets.

Now, when we go home and say we will open the labs, they sit there and look at us and gasp.

Senator **HART**. We might as well continue on that.

Mr. Perle, it seems to me you have two choices, one, to treat his proposal seriously or, two, to simply score political debating points. This means that a proposition like opening up your labs is either serious or it is not.

Is there anyone around this table who thinks that if this proposition had been put forth by a former President, there would not have been universal cries of outrage?

But, I take it from what you have said here that this is not a serious proposal, that it is designed merely to force the Soviets to make concessions that we feel they have not otherwise made—namely, to admit they are pursuing research on strategic defenses.

I guess the real issue here is the seriousness or the merit of whether that is the way you go to a summit. I have to tell you, leaving partisanship and everything else aside, I think it is preposterous for a President of the United States, any President of the United States, to use the summit in that way.

It is not unheard of. It has been done by Presidents in both parties. But it certainly does not seem to me to achieve a serious objective by this country. I fundamentally do not believe this administration is serious about opening the labs of our country to the Russians.

Mr. **Perle**. Senator, let me be clear. We have not said we would open every lab. We have no intention of opening up every lab. That does not mean that it would not be useful to negotiate reciprocal visits to each other's facilities in a carefully controlled and limited manner.

Senator **Hart**. We are not talking about the veterinarian lab of Colorado State University. I assume we are talking about labs where research is done on strategic weapons.

Mr. **Perle**. We are talking about some facilities, not all facilities, and the facilities selected would be selected with a view to permitting some information to flow between us so that we have a better idea of what is going on on both sides. Obviously, we are not at this stage going to hand the Soviets the most sensitive research that we are doing and permit them to make useful observations of them.

Senator **Hart**. Basically, it is a serious proposition?

Mr. **Perle**. A serious proposition to be negotiated.

Senator **Hart**. You can envision the results of those negotiations being Soviet scientists in American strategic labs at some point, under some conditions?

Mr. **Perle**. I think you are getting ahead of the sorts of arrangements that may be possible to negotiate. [Deleted.]

Senator **Hart**. I got close to ours and I had to pass through about 18 security gates and I am a U.S. Senator.

Mr. **Perle**. We could have organized that visit for you so that you could have learned only what we wished you to learn. I think the Soviets would take the same precautions.

I would not judge the proposal until there has been an opportunity to discuss it with the Soviets and an attempt to negotiate some sort of arrangement.

Senator **Hart**. I just want to find out if you are serious about it and I guess you are.

Let me paraphrase your position on ABM and see if I have it right.

The administration, based upon its recent exploration of the negotiating records by both the Defense and State Departments, now believes that paragraph D permits research, development, and testing, but possibly not deployment of virtually all elements of SDI, but since it only discovered this fact in recent weeks and has taken a position contrary to that of the past three administrations, it will not actually change its basic bargaining posture.

Mr. **Perle**. It is not a question of bargaining posture. The conclusion that we have arrived at is as you have stated it.

The administration has taken the position that because the current program was configured with the incorrect and narrow interpretation in mind, an interpretation not borne out by the treaty and record that the issue is moot as to which interpretation applies now and for some period of time.

We made our program—and General Abrahamson may wish to elaborate on this—conform with the treaty. This entailed additional obstacles to success and additional cost, but we did that because we meant what we said when the President said we would carry out the program within the confines of the treaty.

Senator **Hart**. You now say the treaty does not say what everybody else thought it said.

Mr. **Perle**. That is correct.

Senator **Hart**. Which interpretation will prevail in the formulation of this program, the old one or the new one?

Mr. **Perle**. We have drawn the distinction between our legal entitlement, which is consistent with the new interpretation, and current policy, which differs from that, but unlike the law that current policy is subject to change.

Senator **Hart**. In other words, at any moment the administration could decide to apply the new legal interpretation?

Mr. **Perle**. It has that legal right.

Senator **Hart**. We are here to discuss the policy of the country.

Mr. **Perle**. I cannot tell you what——

Senator **Hart**. Who can?

Mr. **Perle**. I don't think anybody can tell you how long we will continue to be bound in a manner that is more restrictive than our legal entitlement.

There is no current element of the SDI Program that could proceed under the broader interpretation, but cannot proceed under the narrower interpretation.

Now, that situation could change. One of the arguments, if I may say so, for making the decision when it was made was that we wanted to make it sufficiently far in advance of a requirement to go to a broader interpretation so that we would not be accused of having manipulated the interpretation of the treaty in order to get around an obstacle that had been encountered.

Senator **Hart**. When you decide, if you decide, to go to a broader interpretation, do you intend to consult Congress on that or do so unilaterally?

Mr. **Perle**. I would think that we would want to consult with the Congress on that. I would hope that the Congress would recognize the dilemma that we would face if we were bound by a narrow interpretation of the treaty, that was approved by the Senate of the United States. It has profound consitutional implications.

Senator **Hart**. What do your two lawyers say, the one in State and the one in Defense?

The one in State says the treaty does not say what they thought it said. This does not mean it is a constitutional question.

Mr. **Perle**. The Senate is full of lawyers. I would hope some of the lawyers in the Senate would take a look at it, too. It seems to me the case is overwhelming. We would not, in my judgment, have made this decision based on a vulnerable legal interpretation.

Senator **Warner**. Before turning to Mr. Thurmond, just an observation.

One of the most serious problems in the whole SDI program is the credibility with the public. For example, the elimination of nuclear weapons is a troublesome thing for me and perhaps others.

Perhaps you could go back and rename this lab thing something other than the open lab. Open means throwing the whole thing open. Call it an exchange of scientists, or something.

Mr. Thurmond.

Senator THURMOND. Thank you.

Mr. Perle, I have to go to the Senate floor at 10 o'clock. I have a couple of questions.

As I understood you to say, the Soviets have the SDI or a similar system and have been working on it for years.

Mr. PERLE. That is correct.

Senator THURMOND. At what stage have they developed it?

Mr. PERLE. They have, Senator Thurmond, activities underway in the same areas that we are pursuing, that is, lasers, directed energy devices we believe, in fact, we know they have a vigorous space program in association with that.

I am unaware of any element of our program that is not paralleled by similar activity on the Soviet side.

Senator THURMOND. You feel we have the best technology and can develop it faster because the thing that the Soviets are harping on is demilitarized space.

I think Mr. Shultz is over there now, and I imagine the same thing has occurred with him. They evidently are afraid we are going to get the SDI developed first and we will be able to knock down their missiles.

Mr. PERLE. I think I would put it a little differently. Up until the spring of 1983, the Soviets had the field to themselves. They were busy at work on an SDI and we were not making any comparable effort. They rather liked that situation. They would like it to continue.

The only way they know to continue it is to stop the American program while they continue their own. I think the slogans about demilitarizing space are nothing more than slogans.

The Soviets will continue to militarize space to the degree they are technologically able to do so. They prefer to do that without any competition from the United States.

Senator THURMOND. Now, Mr. Perle, we have been briefed as to the administration policy that both the United States and Soviet Union should eventually deploy defensive systems. If this comes about and both countries possess defenses that cannot be overwhelmed and neither country can threaten a first strike, what impact will this have on our conventional force imbalance in Europe and to what kind of spending levels would we have to rise in order to maintain a credible conventional deterrent?

Mr. PERLE. I believe that we will need, in any case, to continue to improve our conventional forces, not least of all because the Soviets have acquired significant advantages in theater nuclear weapons and strategic nuclear weapons, and because the utility of the threat to use nuclear weapons to offset a conventional imbalance is diminishing.

For how long we can continue to make that threat effectively, I cannot say. The reality is—[deleted].

Senator THURMOND. The CIA is preparing a briefing for the Senate. [Deleted.]

Would you comment on [deleted] how this relates to the Soviet interpretation of the ABM Treaty?

Mr. PERLE. Let me say, first, the Soviets from the beginning, from the signature of the ABM Treaty, have pursued a vigorous ABM program. Indeed, Soviet investment in antiballistic missile systems increased after the treaty was signed, so they never had the slightest intention of abandoning the search for strategic defenses of both the sort that were available at the time and what were then known as exotic systems, systems based on physical principles.

Some of the facilities to which you refer date to the 1960's and have continued and have been expanded and modernized and upgraded. There is no doubt in my mind, and I think the intelligence on this is overwhelming, that the Soviets interpret the ABM Treaty to accommodate their program.

Senator THURMOND. As I understand you to say a few moments ago, in going forward with SDI, we are adhering to the ABM Treaty.

What were the words you used that the treaty contains, that we can do research and testing, and what?

Mr. PERLE. The treaty prohibits deployment, provides for a mechanism for withdrawal, amendment, and consultation, but it permits research, development and testing.

Senator THURMOND. Permits research, development, and testing?

Mr. PERLE. That is correct.

Senator THURMOND. The treaty provides that?

Mr. PERLE. That is correct.

Senator THURMOND. That is all we plan to do?

Mr. PERLE. That is all we are planning to do.

Senator THURMOND. I will not have time to ask this, but I have one question for General Abrahamson if he wishes to answer it for the record.

Senator WARNER. Do you wish to ask the question?

Senator THURMOND. I do not believe I have time.

Senator WARNER. Senator Nunn.

Senator NUNN. Thank you, Mr. Chairman.

Just one brief response to the statement that Secretary Perle made on the MX, so-called MX agreement, Scowcroft amendment.

I know that you were not a part of that, none of the discussions or anything else. So, I assume you are just basically giving your view about what the deal was based on, what you have heard secondhand; is that correct?

Mr. PERLE. That is correct.

Senator NUNN. For your information, those of us who were involved in that discussion made it abundantly clear from the very beginning, I must have said it 10 times, that I would never agree to 100 MX missiles in fixed-base silos. That was said to the President, to the National Security advisers, to the military people.

So, any implication that there was a deal to go for the 100 MX based on thirdhand hearsay is totally, factually incorrect. This is just for your edification.

Senator WARNER. Would the Senator give the time of that discussion.

Senator NUNN. One discussion? There must have been 10.

Senator WARNER. Is that the one where you and I were in the office of the majority leader?

Senator NUNN. I said that, myself, probably 100 times, at least 10 times to the President and the highest administration officials.

Mr. Perle was not in any of these meetings. I even said 50 back then, I would never go to more than 50. They wanted to get the missile through that year and they made the overall tactical arrangement and endorsed the Scowcroft Commission report in theory based on that desire.

It was abundantly clear—I cannot speak for the whole Congress—I know perfectly well that any insinuation that there was a 100 MX deal made in fixed-base silos is totally incorrect.

I do not know what was said at that particular meeting, I do not recall one.

Mr. PERLE. Senator, I appreciate that clarification. I certainly cannot speak for the whole administration. I wonder, since you were in those meetings and I was not, if you can say whether the administration at any time pledged not to propose to ban mobile missiles in Geneva?

Senator NUNN. I do not know that that degree of cross examination was felt necessary since they had embraced completely the Scowcroft Commission report and said over and over again they agreed with the theory of it, they agreed to going to mobile missiles, they agreed with the single warhead missiles, they agreed for the first time with the definition of the window of vulnerability which had to take into account both bombers and land-based missiles and escape time of bombers, and so forth.

There is no doubt in my mind they agreed to go to mobile missiles. I just wanted to clarify and make abundantly clear that no one could have any misimpression about my own view on that.

Another thing that is very clear is that nobody has banned the MX missile. What we have banned is MX missiles in fixed-base silos.

Part of the Scowcroft report indeed encouraged the administration to try to find other basing modes and explore it vigorously which the administration has totally failed to do. They are continuing to go strongheaded in the way of putting MX's in fixed-base silos and no probing of alternative basing systems.

Mr. PERLE. There has been a lot of probing of alternative basing systems.

Senator NUNN. None that has come to my attention.

General Abrahamson, to what extent were you personally involved in the formulation of the U.S. position on open labs?

STATEMENT OF LT. GEN. JAMES A. ABRAHAMSON, DIRECTOR, STRATEGIC DEFENSE INITIATIVE ORGANIZATION

General ABRAHAMSON. I proposed a think paper which was examined by the policy group and by the people in the Defense Department. That think paper then went over to the administration.

At that point on how it was then changed, I was not involved any further. It was only a think paper about what level of safety and requirements and issues might be involved if there were, and I think a better way to describe it is the way the paper was written, and that was written in the context of mutual inspection, which I think is understood and has been used for a very long time in the whole arms control community for a long period of time.

In that sense, I provided what was a technical judgment about what were safe levels and discussions and inspection.

Senator NUNN. Have you personally examined our proposal that we tabled in Geneva?

General ABRAHAMSON. No; I have not.

Senator NUNN. Have you been briefed on it?

General ABRAHAMSON. I have had a characterization of it, yes.

Senator NUNN. Are you familiar with the details of it?

General ABRAHAMSON. No, sir.

Senator NUNN. Have you had access to that information?

General ABRAHAMSON. What I have said is that it is appropriate, obviously, as is discussed further, that I ought to be able to comment about the levels of safety, the same kind of issues that I laid out in the discussion.

Senator NUNN. So, as head of our SDI program, you are not personally familiar with what is in that proposal?

General ABRAHAMSON. I have not seen all the details. What I have seen is a characterization. I think that is sufficient at this point. It was a broad kind of a statement. If there is a problem there, the problem is, as Senator Warner indicated, it might be in the title.

Senator NUNN. Do you personally agree with the concept as you have understood it, your personal opinion?

General ABRAHAMSON. I believe it is a viable way in which if the Soviets then admit that they do have such a program, that left to the details of a negotiation to figure out an effective means of control, that in fact we could gain a great deal of information about their program.

It would add confidence and credibility of the kind that would assist in this transition period that we have been talking about in the future.

Senator NUNN. You personally agree with it, then?

General ABRAHAMSON. Yes, sir, in that sense.

Senator NUNN. In what sense do you not?

General ABRAHAMSON. In the sense that Senator Hart suggested, that what this might mean is a throwing open of laboratories for Soviet scientists to go digging in every basement.

I am sure that was not the intent and I think it would be very unfortunate if that kind of concept were indeed posed either by people who are critical of the administration or of the attempt to bring about a successful negotiation.

Senator NUNN. If the Soviets were to come back and say we agree with your proposal as you have defined it, open labs, we will open up every laboratory in the Soviet Union and you open up every laboratory in the United States that has anything to do with SDI, if they did that, what would then be your position on that proposal by the Soviets' counterproposal or acceptance of our proposal?

General ABRAHAMSON. I do not believe that is what we have proposed at all, sir.

Senator NUNN. You would not agree with that?

General ABRAHAMSON. First of all, I wouldn't agree with it.

Second of all, I don't think it is in the realm of a realistic kind of possibility.

Senator NUNN. Would that put us at a disadvantage, a true open lab type arrangement on all strategic defense? Would that put us at a disadvantage?

General ABRAHAMSON. The problem is even more subtle than what you have just indicated. The problem is how do we know and how do they know which of our various labs and our various activities are indeed strategic defense or other kinds of sensitive activities that ought to be protected and may not even be associated with that?

Senator NUNN. I agree with that.

General ABRAHAMSON. Therefore, I do not believe that was the intent of the proposal and, therefore, I do not believe that in fact that is an issue.

Senator NUNN. You would then think the proposal has been mislabeled?

General ABRAHAMSON. I think it could be chararacterized incorrectly by people. I think the important part is how it is implemented in negotiation if the Soviets show some interest in it. It is in that particular area that there is both some hope and it can be and could be a serious proposal.

Senator WARNER. Senator Goldwater.

Chairman GOLDWATER. I have no questions.

Senator WARNER. Senator Quayle.

Senator QUAYLE. Thank you, Mr. Chairman.

Is it not true, Mr. Perle, that we have already had Soviet scientists visit our labs?

We have had them visit Livermore and Los Alamos? I do not know that this is a great shock. If it is, you might tell us.

Am I wrong, haven't they already visited our labs, to consider the issue of nuclear weapons?

Mr. PERLE. We have had lots of Soviets visit a lot of laboratories and military facilities—and maybe even some we do not know about.

Senator QUAYLE. Probably a lot more than we know about.

This idea of visiting labs is nothing new. I would be adamantly opposed to opening up the doors.

I also think this would be a logical first step to pose to the Soviets for our satisfaction.

Mr. PERLE. "Open Labs" is the headline. As with all headlines, you have to read the story underneath it.

Senator QUAYLE. This has been done, has it not?

General ABRAHAMSON. Let me go further than that.

Senator QUAYLE. We have in fact done it in the past administrations and this administration. This is nothing new. I think it is right to bring this thing up to see how far we are going to go. I do think there is a little bit of a publicity problem you are going to have on this issue. But Soviet visits have already happened.

If the Soviets agree to opening their labs, I suppose it would be to our benefit. We would gain a lot more out of going to some of their labs and looking at some of their SDI because of what they can already get through our open society over here.

Mr. PERLE. A great deal of what we are doing is known to the Soviets and they go to great pains to conceal what they do from us. There is no question that a reciprocal program would reveal more about the Soviet program than our own. It could help in building confidence.

Senator QUAYLE. I think you will have problems from a public relations point though because open labs proposals sound like we might give away the store, quite frankly.

Finally, I would like to comment on the proposal that if the Soviets would accept our proposal of reducing the warheads to 4,500, abandoning mobile missiles, that would be in the interest of the United States. I would be hard pressed to find too many people criticizing it.

If we are going to be able to achieve a reduction in warheads down to the level of 4,500 and ban new offensive weapons, what is so wrong with that?

I hope the Soviets take the offer. I think it is a good proposal. The people I have talked to in Indiana about reducing warheads and banning offensive weapon systems if the Soviets go along, they are for it.

[Deleted.]

Can you confirm that?

Mr. PERLE. [Deleted.]

Senator QUAYLE. [Deleted.]

Mr. Perle does not wish to go into it in detail in this room. I think it is something we might want to take a look at.

Senator WARNER. We will address that topic in a hearing next week.

Mr. PERLE. [Deleted.]

Senator QUAYLE. I wonder if we might just briefly have the best summary you can give to us on what the Soviets are doing with their SDI. We have heard about our SDI, where the President outlined it. I think it is important that we look at the SDI and defensive capability of the Soviets.

If this is true, this is a major development and it shows what the Soviets are doing.

Could you summarize it for this committee and give us a good feel of what the Soviets are doing with their SDI?

Mr. PERLE. I think the scope of the Soviet program is such that it is difficult to convey the awesome scale of it without going through each of the elements that comprise it, without looking, as we are able to do, at least partially with satellite photography, the size and the complexity and the advanced state of the facilities associated with their program.

As I said earlier, I am unaware of any area in which we are working that they are not working and in many cases they have constructed enormous facilities, some going back over many years, and tens of thousands of people have been at work for many years.

I would suggest, and I know the committee has had the opportunity to get this briefing before, that you keep current with the Soviet development because they are coming at a rapid pace.

Senator **Warner**. That will be the subject of Tuesday's hearing.

Mr. **Perle**. I think, Senator, you will get a far clearer impression from the briefing than we can give in capsule form today, but it is an enviable program.

Let me say this. If the Soviets had available to them the technologies developed largely in our civilian sector that we hope to bring to bear on the problem of strategic defenses, we would be in real trouble.

When it comes to a focused effort on SDI, they are doing a very considerable amount. The things they lack are the ancillary technologies that we have developed in the data processing area, for example, not the SDI program, but just as part of the general evolution of our civilian technology.

It is the application of that technical base to the problem of intercepting ballistic missiles that gives us some hope that despite the size and scale and the historic depth of the Soviet program, we can, with a sustained program of our own, in the end get there first and do a better job.

Senator **Warner**. Senator Exon.

Senator **Exon**. Mr. Chairman, thank you very much.

I must tell you, Secretary Perle, I am extremely concerned about what I must term as other than a clear U.S. position as we approach the Geneva Summit.

The President has many of us confused.

The key question is: Is the President confused?

Is this a devious policy by design to improve our bargaining position at Geneva, or, on the other hand, is the administration and the President truly in disarray as we approach Geneva.

Mr. **Perle**. I think the question is a bit general for me to try to clarify.

Senator **Exon**. Are we in disarray on administration policy about what we should or should not do as we go to Geneva?

Mr. **Perle**. I do not think the administration is in disarray. I think, to be absolutely blunt about it, that there is a certain national disarray which results from a division between the Congress and the executive that greatly weakens the President's position as he goes to Geneva.

There is no sense kidding one another. We all know it. The House of Representatives voted the MX down 3 weeks before the President goes to meet Gorbachev. That is national disarray, not in the administration, but between the branches.

The criticism of our negotiating proposals while they are being put to the Soviets is national disarray. It comes not within the executive branch, but between the branches of Government.

Senator **Exon**. Mr. Secretary, I did not mean to get into a political discussion, but since you have, I am pleased to engage you in that.

You talk about what the House did on the MX missile. That does not seem any more inconsistent with the position that the House has basically had for a long time.

What I am talking about is the evidence of disarray that is coming out of the White House and out of the administration, particularly regarding a vacillating position on the ABM Treaty. Once again the President made what I understand to be a misstatement or a slip. We cannot afford misstatements. We cannot afford slips.

I am just asking you once again, is the President informed about these things or does he go off on his own tangents with regard to important policy decisions of the United States?

Mr. PERLE. I think, Senator, our policy is clear and has been stated many times. I think if one talks enough about these issues, as we are all given to do, that from time to time, there will be a loss of clarity.

I would like to say something more off the record, if you would like, because I think it a matter of such national importance that it might be useful to do that.

Senator EXON. Is it not true, Secretary Perle, that the President was only playing his cards close to his vest regarding what, if any, part of the SDI program is negotiable. This may be wise now, so far as public statements are concerned. Regarding SDI, is nonnegotiation the bottom line position of the administration as we go to Geneva?

Mr. PERLE. Let me state the bottom line position as I understand it.

It is that we will not encumber our efforts to achieve a strategic defense beyond the limitations in the ABM Treaty.

Senator EXON. Let me press you a little bit further on that point.

Assuming that Richard Perle, who we all know is a hard-liner and whom I admire, could be sitting at the right hand of the President and our negotiators at this Summit Conference and subsequent conferences to come, what reductions in offensive forces would be the price for restrictions on the elimination of SDI?

Mr. PERLE. If one were to eliminate ballistic missiles entirely, then the question would arise, is it necessary to have a defense against what would have become a nonexistent threat?

The President's answer to that question is even in those circumstances, one would wish to guarantee the stability of that disarmed condition and protect against the possibility of a madman.

I think there is something to be said for limited defenses under any circumstances. I am not, as some others are, of the view that defenses mean instability. There is no reason why defenses cannot be limited, controlled, agreed upon.

There is a sense that I think is wrong that somehow the presence of a mix between offense and defense is contrary to a stable balance. That is not true with respect to air defenses. There is no reason why it need be true with respect to ballistic missile defenses.

So, while I can imagine limitations on the deployment of defenses that reflect the control of offensive forces, the President has certainly never ruled that out. What he has ruled out, and I think quite properly, is abandonment of a research and development program of precisely the sort that the Soviets have underway and of the kind that we could not possibly verify if there were an agreement to that effect. That is just common sense, Senator.

Senator EXON. Thank you, Mr. Chairman. My time is up.

Senator HART. Mr. Perle, were you as concerned about national disarray and congressional restraint when the SALT II Treaty was being negotiated?

Mr. PERLE. That was after negotiation was over, Senator Hart.

Senator HART. No, it was not. There was a lot of criticism from these halls about the bargaining position of the United States of America in Geneva. I do not think there was a lot of talk at that time about national cohesion.

Mr. PERLE. I think the situations are not analogous. I would hope that you would agree with me that when the Congress of the United States makes demands on the President, that can restrain his hands in dealing with the Soviet Union.

The Congress often acts in a manner intended to strengthen the hands of the President as he enters negotiations, whether it is trade negotiations with Japan in which his hand might be strengthened——

Senator NUNN. The question is about the open lab proposal.

Senator HART. We are trying to strengthen the President's hands.

Mr. PERLE. I certainly do not think it strengthens the President's hands to criticize the American negotiating position on a point where the Soviets are also criticizing our negotiating position as he goes off to negotiate.

I think what was said in 1979 about the SALT II Treaty in no way weakens the President of the United States. If anything, since the prospect always existed of going back and trying to clean that treaty up, that it may well have strengthened his hand.

Senator HART. Something tells me the President of the United States would not have agreed to that at that time.

Mr. PERLE. Well, he came around in the end, obviously.

Senator WARNER. I believe we will now turn to Mr. Wilson and then Mr. Levin and Mr. Bingaman and then we will invite our two colleagues to join us this morning to participate in the questioning.

Senator WILSON. Thank you, Mr, Chairman.

I wonder if we might take Mr. Perle on his offer to go off the record. He indicated he is prepared to make a reply.

Why does it have to be off the record in a closed session?

Senator WARNER. I think it is advisable, if those who wish to hear his view off the record, do so in a less formalized structure.

Will you make yourself available to consult with members who desire it?

Mr. PERLE. Sure.

On the record, I make the plea that in these days before the Summit we not enlarge upon things that may be said which will complicate the President's very difficult task. That is, amplifying remarks, statements that might have been made differently, and more clearly those not in our national interest.

The administration appeals to those here and whose voices are heard, not to exploit those opportunities. I think everybody knows what I am saying.

Senator WILSON. Chairman Warner made a comment about that at the time the Scowcroft Commission made its recommendation, it was aware of the circumstances you had recited as to hardening and mobility. They could not have been aware, in making recommendation for development of a small mobile missile of what it would cost.

It seems to me that cost is inevitably a function, rather a central focus, of our concern, there is no escaping it.

If I understand the administration's position, it is that in pursuing SDI, they are determining its feasibility, and they are determining its being cost effective at the margin.

Is that true?

Mr. PERLE. I think cost effectiveness at the margin is an important consideration, but it is not the only consideration.

Senator WILSON. I agree it is not the only consideration, particularly if what you are talking about as a use for that technology you protect your retaliatory force. That is a point I would like to pursue.

It seems to me that if we can gain assurance that we will make so uncertain the success of their first strike against our retaliatory force, that discussions about cost effectiveness at the margin need a terribly new perspective.

Mr. PERLE. I agree with that. It is an economist's theoretical model. We do not live in a world in which we are privileged always to defend ourselves in the most cost-effective way.

If you set politics aside, there are all sorts of things we can do that we are not always able to do. We pay a price for being an open society and not having missiles deployed in a way that is cheap and effective.

So, one must keep this notion of cost effectiveness in this area in perspective.

You have already touched on the cost effectiveness in your comment on the historical analogy between development of the hydrogen bomb, and current Soviet effort to develop various strategic defenses and the defensive technology that they are urging us to abandon.

The central point you have made well and that is, that we need not gain an impermeable shield, but one that is sufficient to frustrate the Soviet first strike capability.

What disturbs us is the possible acquisition by the Soviet Union of a defensive capability that might not be able to cope with the possibility of an American first strike. We are not about to make a first strike but they might, one that might defeat a U.S. retaliatory strike.

It is a combination of offensive and defensive forces that is so troublesome. If they did not have a formidable offensive, including hard target capability of the sort we do not possess, it would be another situation.

Senator WILSON. I think that is the point to make clear as you enunciate it, develop a capability where they could deliver a first strike and absorb what ragged retaliation we would be capable of.

I assume if they were paying attention to the Scowcroft Commission at the time the recommendations were rendered, that that plan by the Soviets necessarily was predicated upon delivering a first strike against 100 MX weapons. With only 50, that considerably changes the equation and requirement on their part and indeed would mean in their strategy of responding to a ragged retaliation from us that that retaliation might be a great deal more rapid if we are talking about quickness.

Your arithmetic argues very eloquently for itself. The point I want to talk about, and perhaps I cannot [deleted].

Mr. **Perle**. It is a very disturbing element, not least of all because it appears to confirm the fears that some of us have stressed about which there has not been consensus, [deleted].

If that turns out to be the case, then I think this committee and the executive branch have some very difficult decisions ahead of them. I frankly do not know how we can seek to respond. The evidence is unlikely to be conclusive, and unlikely to be conclusive right through the period in which the deployment is taking place.

Senator **Wilson**. My time is up. If I have a second round, what I would like to get into is the whole question of verification as related to mobility.

Senator **Warner**. Mr. Levin.

Senator **Levin**. Thank you, Mr. Chairman.

Secretary Perle, we read in this morning's paper that the President in his talk to the Soviet journalists was imprecise. He meant to use the word "sharing" instead of the word "deployment." He gave a critical answer on SDI negotiability which gives almost the opposite meaning of what he said.

There is another quote in that issue, which we do not have any explanation for which is the following quote?

"The President told the Soviet journalist we won't put this defensive system in place until we do away with our offensive missiles."

Who knows what he meant by that. The White House has not told us yet what he meant by that one. I do not think he knows what he meant by that one. I sure do not know what he meant by that one.

It is different from what everybody has been saying in the last year or two. I presume you do not know what he meant by that. If you do, I would be happy to hear your explanation of that.

There is something else that appears in the paper this morning. The Pentagon officials say that Weinberger approved some features of the limited arms control proposal while opposing others.

I want to know if that is accurate.

Mr. **Perle**. There may have been a point or two of detail, I am really not sure, and the fact I am not sure suggests that it is not very consequential, the differences, if any, between the Secretary's view of the proposal and the proposal put forward.

I have seen articles in the press that make it sound as though there was a terrible dispute in the administration between Secretary Weinberger and Secretary Shultz over this new proposal and that is not the case.

The difference is over timing and tactics. I think around this table the committee might well be divided over the question of timing and tactics, too.

Senator **Levin**. Is it your understanding that there is no difference?

Mr. **Perle**. Certainly no significant difference.

Senator **Levin**. No significant difference on the substance of this proposal between Weinberger and Shultz and McFarlane?

Mr. **Perle**. I am unaware of any.

Senator **Levin**. Would you be aware of any if there were any?

Mr. **Perle**. I think so.

Senator **Levin**. Is it your understanding that the administration is willing to negotiate restrictions on SDI deployment?

Now, we heard this morning a comment about the administration's position on SDI research and development, negotiation relative to those two things.

Your statement is clear as to what your understanding is. I have never been able to get a clear statement from anybody on the question of whether or not the administration is willing to negotiate restrictions on SDI deployment above and beyond what might be in the ABM Treaty.

Mr. **Perle**. It would be hard to go further than the ABM Treaty.

Senator **Levin**. For instance, the ABM Treaty has a 6-month withdrawal clause.

Mr. **Perle**. That is correct.

Senator **Levin**. You could negotiate a longer withdrawal clause as some of our European allies suggest, that there be a 2- or 3-year withdrawal clause. If one side had noticed the other side was going to deploy, you could define what this supreme national interest might be. You could do a lot of definitional work that you might view as more restrictive than the narrow interpretation you now come up with relative to the ABM Treaty.

My question is: Is the administration willing to negotiate any restrictions on SDI deployment beyond the narrow ABM Treaty interpretation?

Mr. **Perle**. We have not put forward such proposals. How we would respond to Soviet proposals if they were made, I think is difficult to say.

I think the general thrust of the administration's policy has been to preserve fully an option that the President believes holds great promise for improving our security and the stability of a balance between us by a blend of offensive and defensive forces.

I think we would be reluctant to encumber our program further. I cannot tell you in the abstract that no proposal the Soviets might make respecting deployment, no matter what it was linked to in the way of treatment of offensive weapons, would be acceptable to the United States.

Senator **Levin**. Or unacceptable?

Mr. **Perle**. Or unacceptable.

Senator **Levin**. You have not removed the possibility of some limitations being negotiated on SDI deployment beyond those that exist in the ABM Treaty?

That is not outside the realm of possibility, although you would be reluctant to do it? Is that the idea?

Mr. **Perle**. We would be reluctant to do it. Frankly, the Soviet position which has been that we should abandon the program entirely, has hardly encouraged us to think about other proposals to which we might respond.

Senator **Levin**. While you would be reluctant to come to the point beyond what exists in the ABM Treaty, it is not beyond the realm of possibility?

Mr. **Perle**. No, it is not beyond the realm of possibility.

Senator LEVIN. That is a difference between the terms of treatment of deployment and the way you treat research and development?

Mr. PERLE. Yes.

Senator LEVIN. Was there a consensus on this latest offer we are making in the JCS?

Mr. PERLE. I do not know.

Senator LEVIN. Are there any ambiguities? Is there any ambiguity in the ABM Treaty as to what testing is allowed of space and mobile-based components?

Mr. PERLE. Is there any ambiguity?

Senator LEVIN. Relative to that issue. Shall I repeat it?

Mr. PERLE. No. What I am trying to come to terms with is the word "any."

There were a great many statements made on both sides during the course of negotiations, yet there is a consistent theme and there is the text of the treaty itself. When one puts that together, I believe the issue is clear, but I cannot tell you that there is no ambiguity.

Senator LEVIN. My time is up. Thank you.

Chairman GOLDWATER [presiding]. John?

Senator GLENN. Thank you, Mr. Chairman.

I sometimes think I feel a little bit like Alice in Wonderland. We are trying to build a system and keep up with the Soviets and keep ahead of them in these areas. Then the President comes out in a direct quote, not taken out of context, he repeated it, we won't put this weapon or this system in place, this defensive system, until we do away with our nuclear missiles, our offensive missiles, but we will make it available to other countries, including the Soviet Union, to do the same thing.

Later on down at the bottom, he says, "I can assure you now we are not going to try to monopolize this."

I cannot imagine our opening our labs and giving this information away. It sort of defies rationality.

I know your general attitude on defense, Dick. I have known that for many years. I find it very difficult to believe that you are in full concert with the administration on this or that the administration is serious.

If we are doing this as a bargaining ploy of some kind leading up to Geneva or leading up to the Summit, then I understand the whole thing, we are maneuvering here, we are not serious about this. But that has not been the indication from the administration so far.

I find this hard to believe that we are going to open the labs. Why are we opening them up? They do not need a Yurchenko; we are going to give it to them. We are giving them the information he was obviously searching for, I guess. That is a spy full employment policy, I guess.

I find this whole thing mystifying.

Tanks are defensive. You put armor around tanks to defend them. Let us say the scientists come up with perfect armor for a tank. You can no longer destroy a tank. I guess the new policy is going to be that we had better share that with the Soviets so that tank warfare is equal on both sides.

Mr. PERLE. I would hope not.

Senator GLENN. I would hope not, too. I would hope that all this talk about sharing SDI and sharing all the rest of this technology with the Soviets and the maneuvering going on in the Pentagon, the State Department and the White House is not serious because I think the American people are not going to support it and I will not either.

Mr. PERLE. Can I try to put it in perspective?

Senator GLENN. Please do. I am mystified.

Mr. PERLE. The President's concept in the long term is that if we were able to eliminate ballistic missiles on both sides, then we could share defenses to protect against cheating. I, frankly, think it is unlikely to happen.

If it were to happen, then one could imagine that, in order to protect that state of disarmament, we would share defenses on both sides so that each would be confident that if the other were to acquire some ballistic missiles, that would not tip the balance.

Senator GLENN. If we have that kind of Nirvana, if we have that kind of agreement, we do not need SDI or anything else. There would be no more wars and we will do away with our weapons systems.

That is so far out, so pie-in-the-sky, that I cannot believe we are serious about this whole thing.

Mr. PERLE. We have very serious immediate objectives in the near term. The most important of those is to determine whether it is possible to develop an effective defense.

Senator GLENN. Will we give up our armor? Let us say we have a perfect fighter airplane. A fighter airplane is strictly defensive. They are like SDI; they deny something to somebody. People have to come in and take it away from them.

Would we give them the perfect fighter?

Mr. PERLE. Of course not. I think what the President is attempting to dramatize, if I may use that word, is that we are not approaching SDI with a view to robbing the Soviets of their deterrent capability. It is not in the context of the search for a preemptive first strike capability that we are pursuing SDI.

He has been trying to underline our intention by envisioning in the long term the sharing of that technology.

Now, one runs a certain risk with a long-term situation like that. It could confuse people about our near-term objectives.

I tried earlier to appeal to you not to magnify the difficulties that we are likely to have in explaining our near-term policies in light of that long-term perspective.

Senator GLENN. Let me ask General Abrahamson. Over the weekend there was quite a detailed article in the New York Times. Some of that I thought was a little sensitive.

I was wondering if we were not starting our dispersal of information and sharing our views with the Soviets and sharing our information already because that article went into some detail. I hope that there was a conscious effort to put some of this out and it was done after much forethought because it went into considerably more detail than I had previously seen in public print.

I thought it was classified, but I was obviously wrong or you would not have released it.

Is this the beginning of the President's policy to open up the program or was that done after other considerations?

General ABRAHAMSON. Sir, there is a certain substantial portion of the program that can and, in my judgment, should be at an unclassified level.

Some of the questions there I think were clarifying, some were taken out of context in the particular article, and certainly it is not part of an overall program saying we have now a planned program to open up larger and larger amounts of the program.

Not at all. But there is, and perhaps I think there necessarily should be, at least some portion of the program that is available to the public.

Senator GLENN. Weren't there several things in that article that had previously been classified, though?

General ABRAHAMSON. I would have to go back. I do not believe so. Perhaps afterward we could sit down and take a look at it.

Senator GLENN. Thank you.

Chairman GOLDWATER. Senator Bingaman.

Senator BINGAMAN. Thank you, Mr. Chairman.

Let me ask first on the reinterpretation of the ABM Treaty. The two legal memoranda that you referred to, one was done in Defense and one in the State Department.

Have those been made available to the Congress?

Mr. PERLE. I do not know the answer to that.

Senator BINGAMAN. Would it be possible to have them made available to this committee for us to review?

Mr. PERLE. I think what the administration would almost certainly prefer to do is prepare a legal memorandum that integrates the views of both Departments. Where the Department of Defense counsel concluded that the treaty gave us even more freedom of action than the State Department counsel, the administration decided to adopt the view of the State Department counsel.

If you wish to examine the memorandum, I would suggest that you get the State Department to make it available.

Senator BINGAMAN. I would appreciate it, myself, if we could get whatever is available in the way of legal memoranda justifying this interpretation so that we could review it.

You suggested you thought it would be useful if some of the lawyers in the Congress would take on the job of trying to make some sense out of this and I think that it would be helpful.

Could I also ask, if this reinterpretation exists, then is it your opinion that both the United States and the Soviet Union could really, without regard to any quantitative or geographical limits, develop and test sea-based, air-based, space-based, and mobile land-based ABM systems and components provided they were based on some of these exotic systems?

Is that your view of what the newly interpreted treaty permits?

Mr. PERLE. That is right, although you mentioned quantity. I think we would take a dim view of many such systems represented as a test program.

Senator BINGAMAN. Right. I can understand that. But it is your view that none of the quantitative or other limits on ABM systems or components that are contained in the treaty apply to exotic systems?

Mr. PERLE. The quantitative limits—I am trying to understand the question—apply to deployment principally.

Senator BINGAMAN. Your thought is that exotic systems still could not be deployed?

Mr. PERLE. That is correct.

Senator BINGAMAN. Under the treaty?

Mr. PERLE. That is correct.

Senator BINGAMAN. Let me just quote to you a characterization of some of the record that went into the debate here in the Congress. This is from testimony that Mr. Rhinelander gave in the House Foreign Affairs Committee a couple weeks ago.

He reviewed, or purports to have reviewed, the Senate Foreign Relations Committee hearings and the Senate Armed Services Committee hearings and he says that that record includes explicit confirmation submitted by Secretary of Defense Melvin Laird, Under Secretary John Foster, and Acting Chief of Staff of the Army, General Palmer, all to Senator Jackson, that development and testing as well as deployment of space-based exotic systems were prohibited.

Senator Jackson, who was a sharp critic of SALT I, but voted in favor of the ABM Treaty, understood this point clearly.

Is that you view of what that record reflects?

Mr. PERLE. I think that is probably right. I think John Foster, Mel Laird and General Palmer were all wrong.

Senator BINGAMAN. You think the Secretary of Defense did not understand what the treaty contemplated when he was testifying before this committee?

Mr. PERLE. I bet you 10 to 1 he did not read the negotiating record.

Senator BINGAMAN. Then your view is that none of the administration officials who were presenting the treaty to the Senate for ratification understood what it contained?

Mr. PERLE. I think I would come quite close to answering that question in the affirmative. Obviously, I do not know which administration officials made a study of this, but I do know something about how the process works, having had a chance to observe closely.

Frankly, the administration as a whole relied heavily on the views of a few individuals intimately involved in the negotiations.

In this case Melvin Laird, and certainly the Chief of Staff of the Army, would have depended heavily on the reports coming from the United States delegation in Geneva and our negotiators.

The trouble begins with claims made for the treaty by Gerard Smith and General Palmer and others at the time that are simply not borne out by the record.

There are other instances of that, too. Gerard Smith made a number of statements in 1972 that turned out subsequently to have had a unilateral character. That is, the Soviets had not agreed to the interpretation that Ambassador Smith expressed and when it was convenient for them to do so, they went ahead and did those things and told us that there was no bilateral prohibition on doing them, and we deferred to that judgment.

Here the issue has not arisen yet.

Senator BINGAMAN. I have one follow-up question here; my time has just finished.

Are you suggesting that Gerard Smith misrepresented what he had negotiated or that he did not understand what he had negotiated?

Mr. PERLE. I think like a lot of people, his desire overwhelmed his appreciation of what had been achieved.

Senator BINGAMAN. I did not understand which of the two you come down on in that answer.

Did he misrepresent or did he misunderstand?

Mr. PERLE. There were statements made at the time of the treaty that went further than was justified by the record. I think that was due to the intensity of hope and desire and a feeling that if we went a little bit beyond, the Soviets might somehow be bound by those statements that went a little beyond what they had actually agreed to.

As I say, there are other instances with which this committee is familiar that did not work. The Soviets paid no attention whatsoever to the statements that we made except in cases where there was a clear-bilateral agreement. Even there, there have been violations.

Senator BINGAMAN. I will have to return to the same question.

Chairman GOLDWATER. Senator Gore.

Senator GORE. Thank you, Mr. Chairman.

I want to thank the subcommittee for its courtesy in allowing me to pose a few questions. I would like to precede my questions with a short comment amplifying on a statement that Senator Nunn made ealier.

As one of the six Members of the Senate and House involved in discussions and negotiations with the President a few weeks ago, it is certainly true that both privately to the President and publicly in speeches to the Congress we made it clear that 50 was the number we were dealing with and they agreed to our arrangement based upon that assumption.

In fact, I had occasion to speak with Mr. McFarlane and others at the time when the action was pending to go down to 50 this year and they confirmed at that time, yes, this is not breaking faith; yes, we do remember exactly what our agreement was; we disagree and wish we could go to 100 in fixed silos, but, yes, you were within the terms of the agreement and this is clearly understood.

I just wanted to amplify that comment briefly before going to my questions. My questions concern SDI.

You have made two statements here this morning, Secretary Perle, which differ with the public's perception of what this program is intended to be. The public's perception is based in large part upon statements that have been made by the President and by Ambassador Nitze.

First of all, you have said that SDI should be pursued even if the sort of plan envisaged by the President turns out not to be feasible because it would be valuable simply to complicate a Soviet attack against our retaliatory forces.

Second, you have said that the cost-effectiveness criterion enunciated by Ambassador Nitze is rather outdated and should not be applied mechanistically.

You gave a specific example. You said that if a defensive system costing $100 billion could be overcome by an additional offense costing only $80 billion, we should nevertheless go forward with such a defensive system.

Now, the President has said in his interview with the Soviet press—and I am not going to quote the statement that has caused so much consternation, I am going to quote another statement—he said and I quote:

> If someone were developing such a defensive system and going to couple it with their own nuclear offensive weapons, yes, that could put them in a position where they would more likely dare a first strike.

Now, the reason for the cost-effectiveness criterion was to establish not price stability so much as arms race stability. It was to deal with the central wisdom of the ABM Treaty as it was interpreted then and now, and that is that if you begin to get competition in limited defenses, this would trigger a double-arms race, both in offense and in defense.

If we follow your advice, when we get to a situation where an increment of offense is only 80 percent as expensive as an increment of defense, would not that necessarily lead to an expanded and accelerated arms race with both nations seeking to spend more to penetrate the defenses of the other even as both nations sought to improve the defenses against the other?

Mr. **Perle**. Not necessarily. It would depend very much on whether the Soviets considered that it was worth $80 billion to recapture a capability that they might not need for the purpose of deterrence.

By the way, I suppose I would amend my remarks and be more cautious and say the fact that the cost to the Soviets of overcoming the system was less than the cost of the system would not be a decisive argument against it. There are still a lot of other considerations.

Suppose, theoretically, that the Soviets now have as their objective forces sufficient to attack and destroy our land-based missiles and our submarines in ports and our command and control facilities with a view to degrading submarine capability further and bomber bases and the like. Just accept that for argument's sake that they are prepared to spend a great deal of money to acquire that capability and acquire *x* thousand warheads and some ratio of warheads to targets and all the other things that you are familiar with, and they have them and they think it is nice to have them. Now along comes the SDI.

The SDI raises questions about whether they still have that capability, but it is going to cost them $80 billion to get it back again by overcoming the SDI.

I cannot tell you that they will conclude it is worth $80 billion to have that capabillity. Maybe then they will settle for a more modest capability, a capability to deter, but not a capability to attack.

Senator **Gore**. Do you think they might then surrender the ability to penetrate our defenses even if they could overcome the defenses by spending less money than the defenses had cost?

Mr. PERLE. I think the burden to them and the resource allocation choice they would face are entirely independent of the burden to us. So, they would look at that in their own terms.

I am quite sure there would be present on the general staff those in Moscow who would say they would rather have more tanks, frankly, than have some theoretical ability to attack preemptively.

That is what I mean when I say we must not apply the cost effectiveness at the margin criterion mechanistically.

Senator NUNN. Will you yield for one brief point?

I think this is an interesting discussion. I think it should be explored.

You mentioned a while ago the undermining of our President as he goes off to the summit. I do not think you realize it, but cost effectiveness at the margin is one of the big things that our negotiators at Geneva have been trying to convince the Soviet side in terms of our SDI Program, both in terms of convincing them of the benign nature of it and in terms of getting them to cut back on strategic offenses at the same time.

This recent article by the Secretary of Defense and what you said here and you said before directly contradicts, right or wrong, and, in my opinion, severely undermines, one of the principal points of discussion at Geneva that our negotiators have taken.

Mr. PERLE. I was unaware of that. I do not have confidence that the argument of cost effectiveness at the margin—maybe the owners and operators of a planned economy have—is going to carry a lot of weight with those fellows on the Soviet side of the table.

Senator NUNN. I would tend to agree with you on that point. I am just saying this fact, whether right or wrong, has been one of our principal arguments to them in Geneva.

Mr. PERLE. I certainly would not knowingly undermine the arguments of our negotiators. I was unaware that that was how they were making the case.

Senator NUNN. That is one of the principal arguments. The question is whether the administration is speaking with one voice.

Chairman GOLDWATER. Sam, General Abrahamson desires to make a statement.

Is that correct?

General ABRAHAMSON. What we had planned was a brief update on some aspects of the program. I would like to point out that this program is so broad and so complex that what follows is only some selected elements.

One of the very important activities over the last year has been our look at the systems and the system activities, how one potential system or one potential weapon plays with another, how they indeed support or do not support deterrence if they are only partially capable.

A series of these kinds of activities is underway. So, what Mr. Gardner is prepared to do, but I would like to hasten to underscore these are very deep and complex subjects, is at least to introduce you to about a 15-minute summary of some of those activities and then I am prepared to go a little further with some of the status of the program.

I thought that is what would be most responsive to the Chairman's request. I would like to introduce Mr. Gardner.

John Gardner is the head of our system activities. This is a very broad activity where we have now gone well beyond the Fletcher Commission study.

I would like to underscore in the Fletcher Commission study that was a series of technical road maps that led to certain technical capabilities.

What was not achieved in that period of time was how you tie these together into a system and the advantages and disadvantages and some of the tradeoffs between systems.

We do not have final answers yet. This is an ongoing activity, but it is imperative that in a period when we have a reduced budget substantially below what we have planned, that we make the investment in the right portion of our technology menu.

That is important for investment as well as where the system will eventually go.

Chairman GOLDWATER. We will have your statement and then we will have questions.

STATEMENT OF JOHN GARDNER, DIRECTOR OF SYSTEMS, STRATEGIC DEFENSE INITIATIVE ORGANIZATION

Mr. GARDNER. I would like to, as General Abrahamson said, spend just a few minutes giving you an overview of the work that we have done to attempt to understand these systems better.

[Chart presentation.]

As General Abrahamson has said, this is an ongoing process. It is a process that we think we are making progress on and it is a process that we believe provides us good insight as to the directions the program can take to allow for the best investment of our technological and economic resources.

[Chart deleted.]

The first chart describes the overall process that we are attempting to accomplish. We, of course, have a program that is aiming toward providing us with the information necessary to support a decision as to whether we should enter into full-scale development of a system of a kind that might come out of this research.

We believe that that decision will be a very complex one and we believe that the amount of information necessary for us to have at that time will be extraordinarily large, more than is normally the case in a matter of this kind.

Our program is structured to provide that information. What we are attempting to do is to ensure that we have a very complete understanding of the kind of initial system that we could be able to field, that would enter into development at that time.

That information would include ability to handle threats and countermeasures associated with those threats, and understanding the way in which the system would fit into our overall military strategy as well as good and detailed information on designs that would be involved in the system and the technical confidence that those designs are capable of operating successfully.

We would have to ensure that some of the key features of the system were adequately represented, that it was survivable in the face of determined aggressive attacks on it directly as well as able to handle and discriminate the most aggressive countermeasures.

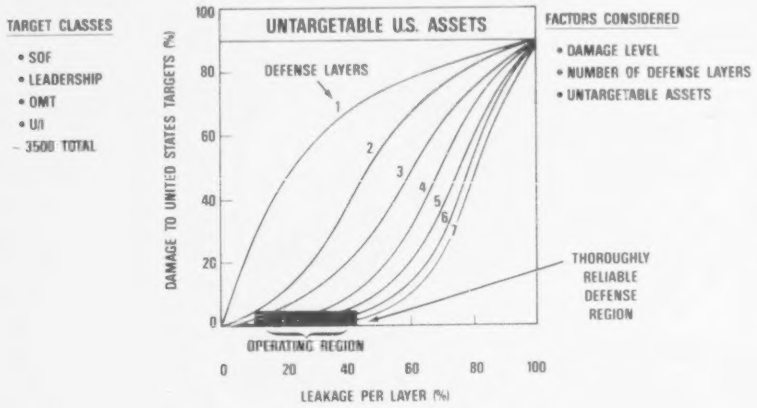
This is a very significant set of hurdles that we anticipate that we will have to jump over in that initial system. We are looking at systems that we believe would be capable of doing that. But not only do we think that we need to have that array of information on an initial system that we would enter into development, but that we also would have a good understanding of the next step in this process that we would be able to describe as the next evolution of this defense and to be able to ensure that there was staying power in the strategy, that the technology was suitable to support significant reliance on this as a military strategy

So, we are intending to provide the information not only for this initial step, but for the next step beyond what this initial step would be. That information will of necessity be somewhat less complete, but we believe it will be extensive.

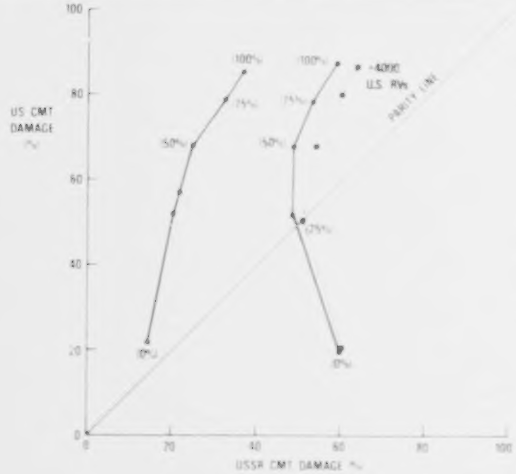
There are two requirements that we are attempting to accomplish in this process. We are looking at and attempting to understand the requirements that have to be applied to these defenses in as quantitative a way as we can.

The next two charts summarize those two requirements.

DEFENSE MISSION: PROTECTION



INCREMENTAL DEFENSE ENHANCES DETERRENCE



SURPRISE ATTACK USSR FIRST STRIKE
(%) OVERALL DEFENSE LEAKAGE

CRUISE MISSILE DEFENSES

US 90% LEAKAGE 90% LEAKAGE
USSR 90% LEAKAGE 10% LEAKAGE

FORCE LEVELS

US START CONSTRAINED
USSR SALT II PROJECTED

WITH POOR CM DEFENSE, BMD REQUIREMENT IS MODEST

WITH GOOD SOVIET CM DEFENSE, VERY EFFECTIVE BMD IS REQUIRED

First, the requirement for protection and then the way in which these defenses would be involved in the overall issue of improving our deterrence strategy.

The first of these discusses the question of protection. In order for us to absorb a major attack on the United States comprised of thousands of ballistic missile warheads [in this particular case the assumption is that there are 10,000 nuclear ballistic missile warheads in an attack on the United States] we have to have very capable defenses and this chart summarizes just how capable those defenses have to be.

In terms of the number of defensive layers that we have to configure into this defense, that is, the number of repeated ABM attack sequences that the defense had to be capable of providing as well as the quality of the defense in terms of how effective each of those attack consequences are, measured here in terms of leakage or lack of perfection of that ABM attack, we expect to be able to build defenses that would operate in this region, that is, defenses that would operate such that the effectiveness of a small ABM attack would be on the order of 60 or 70 or 80 percent effective.

That is, the defense would be imperfect to the extent of allowing 10 or 20 or 30 or 40 percent of the weapons to leak through that particular attack layer.

Since the defense can never be perfect in any particular layer, what we have to do is to configure these defenses so that a large number of layers are designed into the defense.

As you can see, in order to get to the operating region that we are striving for, we have to have four or five or six or perhaps seven layers of defense capability built into the system.

So, this is a requirement on our program and it is a requirement on the defenses. It is a requirement that we believe we can satisfy. I will attempt to describe the way these defenses operate just briefly in order to provide you with some understanding of how we are attempting to get this number of layers.

The question of deterrence and the contribution of defense to deterrence is a more complicated subject. In order to understand this question of deterrence, you have to look analytically at the consequences of offensive and defensive forces on both sides, not only the ballistic missile forces, but the air-breathing forces as well.

This is a set of analytical calculations looking at those two-sided exchanges. In this case what we are analyzing is the following situation: The presumption here is that the Soviet Union has attacked our military forces, both our strategic offensive forces as well as our other military forces.

We have defended against that attack to some level, that level being measured by this numerical quantity. Either the defense is perfectly incapable of handling ballistic missiles, that is, 100 percent leakage, or it is progressively higher in performance, that is, its leakage is less.

We then with our remaining offensive forces counterattack against the Soviet Union, they defend against those forces, and what we then measure is the outcome of that so-called two-sided offensive-defensive exchange.

It is difficult in this area of deterrence to find adequate measures of merit for the consequences of such military exchanges. We are continuing to work on a better understanding of that.

The best measure that we have been able to acquire so far is to assess the net military and economic supporting capability that results. That is, we have summed the net military capability that the United States and Soviet Union have, measuring our military forces, our residual strategic offensive forces and the tightly associated urban-industrial capability necessary to support that.

Some [deleted] or more targets are cumulated into this measure and some [deleted] or so Soviet targets are cumulated in this measure.

In order to understand that process, you also have to appreciate that not only do ballistic missile defenses figure into this calculus, but also cruise missile defenses as well.

What we have shown here is a case in which the presumption is that neither side has very effective cruise missile defenses. That is, it is presumed in these calculations they are both 90 percent leakage.

This is the line of parity between these two sets of military capability. You can see that in the position in which we stand now, which is no defenses, such an exchange is in favor of the Soviet Union to some substantial amount.

As both sides get defenses that are increasingly better, you can see that the net damage that results from this process is reduced and moves in our favor, in this situation where cruise missile defenses are relatively incapable.

[Deleted.]

Senator **Nunn**. Why do you use that assumption?

Mr. **Gardner**. This is an estimate of a possible future world. It is a number of different military force configurations that we could find ourselves in in the future. It just happens to be a convenient one for these sets of calculations.

We have done other calculations and I will show you one sensitivity to offensive forces that adjust these force levels to some extent. There is obviously no right answer here and this is a place in which we have conducted analyses.

Senator BINGAMAN. Is there part of that chart we are not seeing here?

Mr. GARDNER. I will show you an overlay which looks at the consequences of cruise missile defenses on the Soviet Union part which is this next overlay.

If you adjust this assumption on the quality of the cruise missile defense such that the Soviet Union is now presumed to have a highly effective cruise missile defense holding all the rest of the assumptions constant, you can see that there is a fairly dramatic shift in the results of this two-sided exchange.

What these calculations tend to tell you, and they should only be represented in terms of their broad training, is that ballistic missile defenses are still quite effective from the viewpoint of the United States, cruise missile defenses are quite effective from the viewpoint of the Soviet Union.

Other conclusions could be drawn from this, but certainly those are the dominant conclusions. You can see that as defenses are included, the net residual damage that results from this two-sided exchange is declining on both sides partly due to a balance between the relative capabilities of ballistic missile defenses on our part and by the combination of ballistic and cruise missile defenses on their part.

We have looked at one offensive force sensitivity to these calculations which is the last point I would like to make.

Senator NUNN. Excuse me. May I ask about an assumption or two here?

What do you assume about first strike and what that does in this chart, what the first strike does to our offensive capability?

What is that assumption.

Mr. GARDNER. The assumption here is that these defenses are capable of operating at these varying performance levels independently of the significance of the attack, that is, the defenses are adequately survivable, that in the face of direct attacks on them, they are capable of operating at these varying performance levels.

Senator NUNN. The first strike does not in any way diminish the defense capability on this chart?

Mr. GARDNER. What it assumes is that the defense is capable of operating at this performance level in the face of a first strike.

Senator NUNN. Is it wrong to say, then, the first strike has no effect on the defensive capability?

Mr. GARDNER. No, sir, I do not think that is the proper interpretation. I believe what you rather should say is what we have to do is devise a defensive system technology that is capable of operating at this performance level in the face of a first strike. That is what we are doing.

Senator NUNN. I am saying from this chart you have assumed we have done that?

Mr. GARDNER. That is right.

Senator NUNN. For the purpose of this chart, you have assumed the first strike does not affect our defensive capability?

Mr. GARDNER. If that effect were to occur, that we would have accommodated that effect in the design of the defense.

Senator NUNN. For the purposes of this chart, you have said that we are not affected by that first strike. Our systems have been designed so that the first strike by the Soviets has not affected our defensive capability?

Mr. GARDNER. That is correct.

Senator NUNN. Thank you.

Mr. GARDNER. We have done one brief sensitivity on this particular set of calculations of the impact of this particular assumption which is the force levels in this case on the U.S. side.

[Deleted.]

So we are beginning, we believe, to understand the consequence of defenses in deterrent posture.

As you can see, as defenses get better on both sides the U.S. position, in this case, is moving more toward parity than it is in the face of no defenses at all.

We are encouraged that the introduction of defenses into our military forces will serve to improve our deterrent posture.

The next several charts then go into this process in some more detail of the way which we are configuring defenses to provide these capabilities. We have identified three classes of defense systems that we believe can contribute to this military defensive capability.

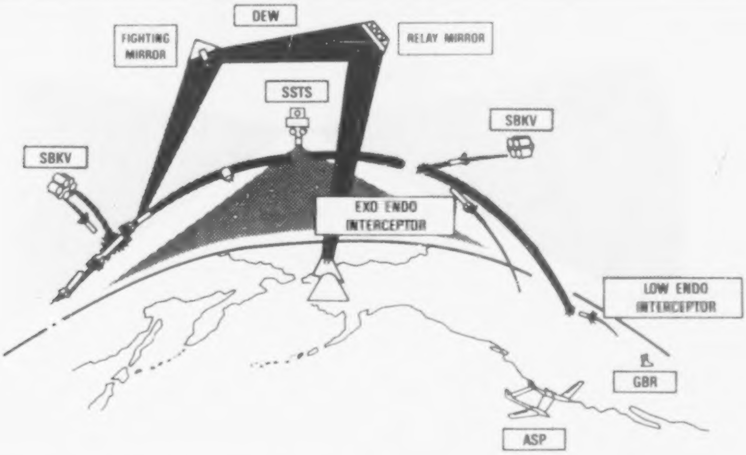
The first, and the one that we looked at in more detail, is defenses that utilize extensive space-based assets. The characteristics of those defenses are summarized here.

SYSTEM ARCHITECTURE CLASSES

- ARCHITECTURE UTILIZING EXTENSIVE SPACE-BASED ASSETS
  - MOST ROBUST, FLEXIBLE, EFFECTIVE
  - MAKES FULL USE OF EVOLVING TECHNOLOGY
  - EASIEST ACCESS TO BOOST, POST-BOOST
- GROUND-BASED ARCHITECTURE WITH POP-UP DEW
  - CAN BE HIGHLY SURVIVABLE
  - MAY BE QUITE COST EFFECTIVE
- ARCHITECTURE TO ADDRESS THEATER DEFENSE
  - THREAT CHARACTERISTICS MAY REQUIRE UNIQUE DEFENSE CHARACTERISTICS

Let me say those defenses we believe are in general most effective and one of the primary reasons for that is that those defenses provide us with the ability to make intercepts in the boost and postboost phases, those phases where the leverage of defense, we believe, is higher.

A STRATEGIC DEFENSE CONCEPT



There are other defensive architectures that we are studying. In particular we are looking at defenses that are based on the ground and whose defensive components, be they sensors or directed energy weapons or interceptors, are popped up and make ABM intercepts in space, but are terrestrially based. We have studied these defenses less. We believe they are—they are promising also and we continue to study them.

In particular, we believe they are highly survivable and even though their performance levels are lower, we believe their cost could also be lower and, therefore, they themselves, could be quite cost effective.

Finally, we are also paying considerable attention to the question of defense of our allies to the theater range missiles that threaten them. We are looking at specific configurations that are capable of supporting that notion.

Senator BINGAMAN. You do agree that first category you are looking at the most is by far the least survivable?

Mr. GARDNER. We do not believe it is by far the least survivable, no, sir. We believe we will be capable of defining these systems in such a way that they will be adequately survivable.

We also believe that that technical problem will be more difficult in this case. Although difficult, we think it is achievable.

Senator NUNN. In your architecture can you visualize at this date, and I know it is a long term question, can you visualize two countries having that kind of survivable defense up there in space?

Mr. GARDNER. Yes, sir, we can.

Senator NUNN. Both of them would be survivable?

Mr. GARDNER. Yes, sir, we can.

Senator NUNN. How far have you gone on that model?

Mr. GARDNER. We are just beginning to understand that, in all honesty. I think General Abrahamson will speak to that question.

General ABRAHAMSON. I will talk about some specific survivability contexts that can be deployed for systems in space, satellites, but are very difficult to be deployed for missiles traveling through space or coming from the upper atmosphere.

The key here is that we really must find the place where the fundamental advantage is with the defense or the place you deploy the system. That is not an easy search.

Unlike all too many who have already concluded, based on their concept of what satellites look like today, and what satellites might be limited to in the future, I just do not accept the idea that that is inherently not survivable.

Mr. GARDNER. Let me conclude my discussion with a brief summary of some of the first broad characteristics of a defense configured in this way and then speak briefly to some of the more detailed examples of such a defense system configuration.

The next chart summarizes in conceptual terms, the way in which such a defense would operate. The attacker is coming from here, is coming into the North American Continent here, and the defenses are configured with a number of basic components summarized in this chart.

[Chart deleted.]

First, there are two classes of defensive weapons in this architecture. One identified here as a space-based kinetic kill vehicle and the other one as a ground-based directed energy weapon operating with a two-mirror relay. Those are the two defensive weapons that are capable of operating in this defense in order to make intercept in the boost and postboost phases.

The kinetic kill vehicles are capable of making intercept in the midcourse phase, those that are located in orbit separate from the ones that happen to be over the Soviet Union at the time attack occurs.

In addition to these two space-based defensive components, there are also interceptors based on the ground in the vicinity of the location that would be under attack and these include both a long-range interceptor capable of making exoatmospheric and high endoatmospheric intercept as well as a low altitude interceptor operating within the atmosphere.

So, there are four weapons in this system. These weapons are supported by several sensors. One of the key sensors is a space surveillance and tracking system [SSTS] located in medium Earth orbit that is capable of doing surveillance against all objects that come into space as well as doing surveillance of rockets against the harder Earth.

It provides attacking information for intercept against the boost, postboost, and midcourse phases.

There are also two other sensors in this system, one is an airborne sensor system that contains optical sensors similar to this optical sensor program, providing surveillance of the residual of threatening objects that have not been destroyed as a result of previous defense action.

We envision this airborne sensor system as being on a platform orbiting at high altitude, 50,000 or 60,000 feet, and deployed around the periphery of the defended region.

Finally, there is a ground-based radar that works in conjunction with this airborne optical sensor system to support these later phases of the defensive system.

Senator BINGAMAN. The underlying assumption here is that the Soviets would launch a missile attack without first taking out any of our space-based assets; is that right?

Mr. GARDNER. That is not correct. In fact, the next chart allows me to speak directly to the question.

This identifies the concept against which we are operating. We have at least an example of a design that is consistent with this concept in which we have gone through and configured the defense system and another to a considerable level of detail.

[Deleted.]

So, the defensive system has been configured to handle just that kind of circumstance.

What we have shown here and what this summarizes is some of the numerical quantities and general design characteristics necessary to handle that size threat. [Deleted.]

So, this is an example of a very aggressive defense system configuration that we believe is capable of performing to a very high level of effectiveness in the face of a very large attack.

Senator BINGAMAN. Is it fair to say you are assuming no attack on our space-based vehicles by any of their space-based vehicles in this example?

Mr. GARDNER. No. We are assuming that there would also be a potential attack [deleted] that could directly threaten our weapons. We have not yet done calculations on an attack on their part of space-based components specifically configured against this defense except in the following sense.

[Deleted.]

Senator NUNN. You are assuming [deleted] on both sides, or something like that?

Mr. GARDNER. [Deleted.]

Senator BINGAMAN. [Deleted.]

Mr. GARDNER. [Deleted.]

Let me conclude this discussion with some brief observations on what we have found about this process.

I again would like to caution you that these are conclusions that we have reached at the early portion of our study. We have a lot of work yet to do. Nevertheless, we believe that we are beginning to understand some of these issues better.

For example, we believe that defenses that are capable of intercept in the boost phase are very important. This is especially the case against very large threats under the assumption that offensive arms control is not successful and the defensive system has to be capable of handling very large threats measured in the tens of thousands.

We believe that the ground-based terminal and midcourse defense can operate, but it requires we solve the problem of midcourse discrimination. The midcourse region of the flight of an ICBM is a region in which a large amount of time is spent, with the threat coasting through space at high velocity.

The defense performance is greatly increased if it is capable of efficiently attacking in that region. In order to be able to do so, we have to be capable of solving this midcourse discrimination problem. We believe we have promising concepts to do that.

SYSTEM ARCHITECTURE STUDIES
KEY OBSERVATIONS

- **BOOST PHASE LAYER NEEDED FOR LARGE THREATS**
- **GROUND-BASED TERMINAL AND MIDCOURSE DEFENSES CAN PROVIDE SUBSTANTIAL DEFENSE CAPABILITY WITH MIDCOURSE DISCRIMINATION**
- **BOOST, POST-BOOST AND MIDCOURSE DEFENSES COMPLEMENT EACH OTHER**
- **TERMINAL DEFENSE CAN:**
  - **REDUCE OVERALL LEAKAGE**
  - **DEFEND AGAINST DEPRESSED TRAJECTORY SLBMs**

As we have looked at these defenses, we have found that boost, postboost and midcourse defenses complement each other. That is in those cases where the boost-phase defenses operate better, it relieves some of the stress on midcourse defenses and in fact makes the discrimination problem, we think, somewhat simpler.

There are important synergisms that we believe can be exploited here.

Finally, the terminal defense systems are the last phase of the defenses to operate. They generally are the ones that we understand the best technically and they are important for two significant reasons.

They are the things that establish and reduce the overall leakage of the system, we believe, to potentially very low levels. Especially they have to be capable of offering defense against the first trajectory ICBM.

In this respect, these defenses look similar to theater defense of tactical ballistic missiles that threaten our allies. We believe there is a goodly amount of synergism between terminal defenses that operate in our own favor and terminal defenses that operate in support of our allies against shorter range missiles that threaten them.

Senator NUNN. What assumption do you make here about how much of this information has been shared with the Soviet Union?

General ABRAHAMSON. Of the specifics or what?

Senator NUNN. The whole question. You have made a very, very big assumption about their countermeasure not being effective against our defenses and they not being able to knock down our defenses.

Obviously, if you are sharing data, sharing technology and you are jointly working on the countermeasures, it would be much more forthcoming.

Have you assumed they know all the essential details of our system in projecting their own countermeasures, or have you assumed they do not know how our system really operates?

General ABRAHAMSON. Obviously, we are assuming from a military viewpoint that there are parts of the program that have to be intact, absolutely effective clearly.

Now, the question on sharing. There are lots of different kinds and ways in which you can share. It might be worthwhile to talk about one and it is here now. I am not suggesting this is the way one would share.

Senator NUNN. You are assuming that we are able to keep our key technology secret in this?

General ABRAHAMSON. Yes.

Chairman GOLDWATER. Thank you very much.

Senator WARNER. I am told that Mr. Gardner in his presentation did not put quite the emphasis as he did with me in previous discussions on the significance of the layered defense.

Could you amplify on that?

Mr. GARDNER. Let me briefly summarize the point. As we have looked at and attempted to understand the ways in which directed energy weapons operate in these defenses, we have found that they have some real strengths that we address now and our understanding of those strengths can probably best be summarized by appreciating the degree to which those directed energy weapon concepts can have very high defensive firepower.

Because the defense systems operate with directed energy weapons at the speed of light, what happens is that the amount of time required for a directed energy system to operate and destroy a missile is very short, on the order of one second or less.

We are looking for directed energy weapon concepts that can destroy a target within a quarter of a second or so and we are looking for sensor systems that can recognize that that weapon has been destroyed and slew to another weapon in three-quarters of a second maximum.

So, the total time that will be required for a directed energy weapon to destroy a target is very short, on the order of a second.

Now, since a ballistic missile flies during its vulnerable boost and postboost phase for tens of seconds in the most extreme case and hundreds of seconds in the case of existing ballistic missile systems that threaten us now from the Soviet Union, not only the ones they have now, but the ones that are in their R&D chain, it means that the defensive system, utilizing directed energy weapons, can have a very large number of potential layers operating in this boost phase.

The exact number, of course, depends on the configuration of defense and configuration of the attack, but the number can potentially be very large.

We look at that as a significant advantage that this emerging technology provides us. We have to find ways to exploit this advantage even more aggressively than we have already.

Senator WARNER. In other words, the seven layers provide seven engagement processes?

Mr. GARDNER. Yes, sir.

Senator WARNER. General Abrahamson, I understand you have a chart presentation. Then we will turn to questions.

General ABRAHAMSON. I would like to build on what Mr. Gardner has laid out in terms of the status of some parts of the program, indicate areas where we are putting emphasis, including some of the space-based survivability issues and some of the ideas we are aiming at. In addition, I'd like to point out some of the rather unique things that we have found on the side that are beginning to come out of what I now regard as some of the most creative phases of the program itself. I would like to build on that and lay out some of our scheduling. We are assuming that we will be able to maintain a reasonably planned funding profile in some of these programs.

If you recall, I indicated that the Fletcher Commission started with a series of technical roadmaps. Many of those technical roadmaps included things like this where they are looking at very, very specific technical problems. These were funded separately as a specific technical problem and now in some cases we are taking these and putting them into an integrated program.

We are not giving up this emphasis on fundamental technology; that is the key to someday making such a thing affordable as well as effective, but we are consolidating both management and project size where it makes sense to do so.

You will recall that in the architecture John Gardner laid out, one of the most important things is to be able to destroy a missile very, very quickly in the boost phase.

One of the most attractive technologies, not only how it fits into the architecture, but also in the progress we have made, and we have made incredible progress, is in what we have called the free-electron laser. We have pulled together a large number of free-electronic laser technologies and put them into a single program. I will briefly define how a free-electron laser works.

[Chart deleted.]

The key point here is that this is an integrated program building on the demonstrated progress at Livermore of the largest and most efficient of these devices in the world, and by the way, free-electron lasers were only an idea about 3 or 4 years ago. We have made very substantial progress.

So, the first point is that we are pulling many of the basic technologies in, not in all cases, by the way, certainly not in all cases, but in some cases, into integrated technology.

Now, in this case it will be an Army headed integrated experimental program, but it will involve the Air Force for the reflecting mirrors in space which Mr. Gardner talked about. It will involve particularly the scientific team at Livermore and many industrial teams that have supported them in their efforts, and the large systems that we will put at White Sands as an experimental system.

[Chart deleted.]

Let me offer you at least a schedule and you can begin to see some idea of the cost. I have not accepted all these costs in the out years, but we have tried to set it up the way we do with all these integrated efforts, so that we have very important key milestones which must be demonstrated before we move ahead in the next phase of the program.

Therefore, we are trying to put together a managerially prudent program, but at the same time one that is aggressive and a challenge to the creativity of the scientists.

Now, the key is that we should be able to have somewhere in this [deleted] time frame a [deleted] laser out at White Sands in an experimental facility. It should be built in such a way that we do not have to make any significant changes to quickly increase the frequency at which this particular laser is operating. You should also be able to demonstrate by the 1990's [deleted] but further than that with just some very minor modifications, not making large changes, you are in the [deleted] of watts of power.

Now, that is the kind that we believe is important. So that you can measure that against as a matter of——

Senator WILSON. At some point can you compare what we are doing with what the Soviets are doing at Sary Shagan?

General ABRAHAMSON. The Soviets have at this point, and it is a little hard to tell, somewhere between [deleted]. They are a little older. There are more understood [deleted] types [deleted] located at Sary Shagan which is a test site which is dedicated to antiballistic missiles.

Senator WILSON. Where would you locate their effort on that chart?

General ABRAHAMSON. As I indicated, several of them are in the power level shown here, some are in the [deleted] category.

[Deleted.]

It is the MIRACL laser out at White Sands which we are just now hooking up to a beam director. The beam director is a telescope that allows them to point up in the sky and direct the laser so it can be used as a weapon.

Now, the important point is when I talk in open testimony and say I believe we will have sufficient information so that a reasonable development decision can be made in the [deleted] timeframe, it is based on schedules that are laid out that will have in this case a ground-based laser that is clearly twice as powerful as the largest laser envisioned and talked about in the Fletcher study.

By the way, the Fletcher study talked about this kind of laser being ready after the year 2000, but we believe the progress has been so significant that we are skipping several steps that the Fletcher Committee laid out.

We still think we have a prudent program. That does not mean that we do not have surprises in here; we could. We believe that in fact it makes sense to lay out and embark on this kind of effort.

Senator EXON. As I understand it, you are saying this significant progress we have made over what you had anticipated, as I understand, is basically because the free electron technology has developed faster than we ever anticipated.

General ABRAHAMSON. In the free electron laser, yes, sir.

Senator EXON. Do I take it, then, that you are satisfied with our advancement in other areas?

General ABRAHAMSON. No, sir.

Senator EXON. Or is that the free electron laser technology is right now advancing at a more rapid pace than the other?

Can you clarify that for me?

General ABRAHAMSON. We have demonstrated, we have real evidence, which gives us very high confidence, by the way, that this is a prudent program. This is not just the judgment that several of us at SDIO make, we have had scientific teams examining the progress of the free electron laser throughout the summer. It's importance is twofold.

One, that we have technical progress in this particular realm of technology, and I will show you other things that go with it, but in addition, as our system studies come together, it has illustrated the value of the ground-based laser going off reflected mirrors as a very valued part of a future SDI system.

You have to have both. Now, there are parts of the program that have as much promise as this in many areas that I have been forced to cut out of the program to move into what I call a backup technology area, primarily just because of funding.

We had to make choices. I believe it would be irresponsible to just try to bring the whole wave of technology to forward year after year and with the cut on the part of Congress that takes out a quarter of the program to just keep slowing it down.

I think what I owe you is management judgments that are made as well as we can possibly make them that continue to move us toward that goal as quickly and as effectively as possible. That is what we are doing.

But is it not enough to be able to only have a ground-based laser. This would not be a weapon that would be effective in the boost phase unless you can get it up through the atmosphere. Therefore, the successful test that we did against first airplanes and then in June against the shuttle, which was now more than a procedural test. It was not a test that gave us a great deal of confidence that we solved the scientific problem of getting through the atmosphere, but in the last 6 weeks we have twice now at low power, and I would like to stress that, at low power, demonstrated at Maui in Hawaii that we can project laser energy up through the entire atmosphere and we can correct with computer controlled mirrors the problems that the atmosphere introduces.

That is a complementary technology that is absolutely critical because we can make the biggest lasers in the world and stick them on the ground, but unless we can project that power up through the atmosphere, it is useless.

So, it is in parallel progress that has been so very important and another element in our decision to say let us proceed and work in that kind of system.

Again, there may be surprises at high power, but nonetheless, we believe in our theory and we have some very substantial models that give us confidence in our low-power work.

Now, that is one kind of weapon and I will spend a lot of time on weapons this morning, but I would like you—please do not forget the weapons are only a small portion of this. In fact, it is the putting together as a system with the capability of data handling, data processing, command, and control reliability that develops the sensors that are important.

John Gardner told you that in the midcourse, moving into that second set of layers, that we have to be able to do discrimination.

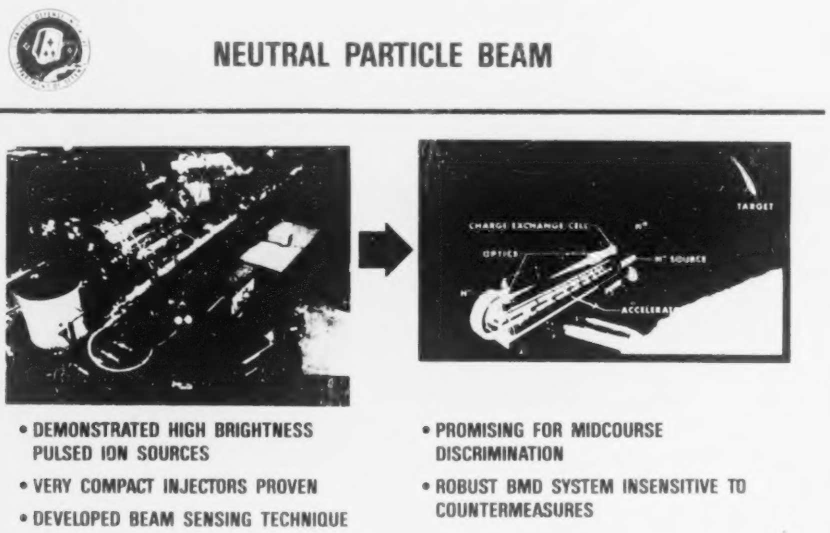
We have to be able to tell the difference between a warhead and a decoy.

Some of the things that the Soviets can do is to either produce decoys that are simple and cheap or have throwaways associated with their missiles.

At the time of the Fletcher study most people felt if we can build very, very accurate heat-seeking telescopes and mount them in satellites, that we can see well enough to tell the difference.

Our system studies indicate to us that may not be good enough. The Soviets may well be able to find ways to fool just passively looking systems.

So, we think that we need interactive systems. Our tests at Los Alamos using an existing small neutral particle beam test stand that we have, I stress small, certainly not one scaled to a full-weapon size, but those tests have shown us ways that even in a [deleted].



NEUTRAL PARTICLE BEAM

- DEMONSTRATED HIGH BRIGHTNESS PULSED ION SOURCES
- VERY COMPACT INJECTORS PROVEN
- DEVELOPED BEAM SENSING TECHNIQUE
- PROMISING FOR MIDCOURSE DISCRIMINATION
- ROBUST BMD SYSTEM INSENSITIVE TO COUNTERMEASURES

[Deleted.]

Now, that means that we have been able to take neutral particle beams. It turns out that a neutral-particle beam at higher power is also a very effective weapon and it is a different kind of weapon than a laser.

The things you would do to counter a laser would not be effective against a neutral-particle beam. That is a stream of hydrogen atoms you would like to shoot at half the speed of light, something like that.

So, this concept offers us again a great deal of promise, but it is a very difficult engineering job and there are probably some scientific problems.

Chairman GOLDWATER. What kind of power are you talking about?

General ABRAHAMSON. Power to drive the system, sir, or power to come out of the system?

Chairman GOLDWATER. Power to drive?

General ABRAHAMSON. Power to drive this kind of system is very, very high in levels. We are probably talking about between 2 and 4 million watts of power for a very short period of time, just fractions of a second for each shot.

Unfortunately, it is very high levels of power. None of these things, lasers, neutral particle beams, any of these things, very few of them are efficient at all in the sense of the way we measure electrical efficiency and motor output and motor input.

Senator WARNER. Can you give us any idea of the magnitude of the installation?

General ABRAHAMSON. Yes, sir. If you were to build it as a weapon, it would be quite large. It might be two shuttle loads put together. It would be a very large thing.

[Chart deleted.]

One of the other areas of interest is the cost of transportation and how we bring that down. There are studies that are going to accomplish that. An early experiment that can demonstrate this capability to use to pull together the problems of building and putting such a thing in space is called STARS. It really means a signficant technical achievement in research; some of our people got a little too public affairs conscious. The important point I would like to make is that this is another of our integrated experiments bringing together many areas of smaller component work that we are aiming for in the [deleted] timeframe.

Again, I am trying to show how these come together for a decision. Are they weapons in the sense that they are full weapons ready to go?

No. Are they an important step toward moving to a deployable system and having a minimum time in the development phase afterward?

Yes, very, very much so.

So, this chart shows one getting up about that timeframe.

You will recall that John Gardner talked about the relationship of the space-based kinetic-kill vehicle. Probably the way to think about this is to recall some of the air-to-air missiles that we have on our fighters.

What we are really trying to do is build an air-to-air missile, only put it in a rocket and fire it in space, something inexpensive and effective in that sense.

[Chart deleted.]

Here is the schedule and it is now marching down through a series of contractors, narrowing them down for a full-scale decision, engineering decision, but with space experiments somewhere here in the 1990 timeframe.

Again, I am trying to show you the various kinds of projects, we are trying to build them in such a way that they come together in that timeframe. If we can move this to the left, boy, I would be delighted and I am continually bounding on the teams that are doing that.

But in the case of SBKKV we will have an early demonstration by next summer of the kinds of equipment that we are talking about here.

Here the challenge is not can you hit a booster? Frankly, we know that already. The challenge is, can you build one of these things of the right technology content so that you can get down below cost which presently is set at $1 million per vehicle.

As we go through each step of the research process, we will be looking to see if we have the kind of technology that may offer us out in production someday that kind of low-cost system.

Mr. Gardner talked about the fact that there has to be some capability or it makes sense to have some capability on the ground and that you would fire upward. In some cases there may be some more cost-effective solutions.

[Chart deleted.]

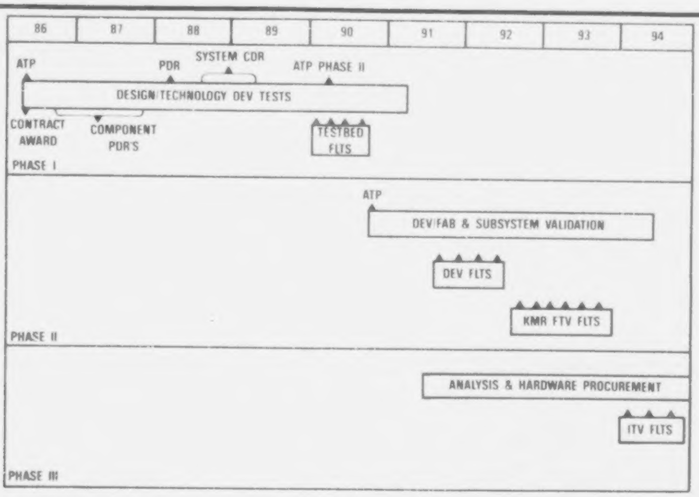
One of the Army programs is ERIS. The importance of the ERIS program is that it is the follow-on to the successful Army homing overlay experiment of June 1984. That experiment was thousands of kilograms. That was an over [deleted] kilograms research vehicle.

We are now looking at the kind of system that will bring this down again to a very low-cost system. Does that mean we are in a development phase?

No. In fact, we are not buying a whole bunch of the production paper that goes with it. What I am searching for is trying to have the people be as creative as possible in finding the right technology to bring the cost down and maintain reliability.

Now, this again is to point our test out here about the 1990 timeframe.

HIGH ENDOATMOSPHERIC DEFENSE INTERCEPTOR



This is the one that goes in the atmosphere. It is high in the atmosphere, but it intercepts in the atmosphere, the more traditional type and one more time you can see that the flight timeframes are down again in this same timeframe.

I would like to move that even further to the left. In fact, we will announce this contract in late November or early December. What is going on in these programs now gives us confidence behind these kinds of schedules and to proceed?

Take the last one I talked about, a high endoatmospheric interceptor [HEDI]. The technology challenge is to be able to have a window that you can see through, that when traveling at very, very high speeds. The challenge is to ensure that the window will not be heated in such a way that the infrared sensor cannot see the warhead as it is coming back into the atmosphere.

The windows are undergoing wind tunnel tests. It is a real technical challenge to be able to make a heat-resistant window; it's probably the single toughest job. The rest of it is not very difficult; we have made rockets for a long time, we have made effective guidance systems.

Here is mach 10 flight of one of those reentry bodies. We are interested in understanding what happens when the maneuvering jets fire and what kind of distortion scene that creates.

And then, obviously, when we look through the window, we are concerned whether that scene will interfere with the ability of our guidance systems. We have a very specific, very technically-oriented program underway.

Chairman GOLDWATER. General, how does the arrow affect that jet on the passage of atmosphere over the cone?

General ABRAHAMSON. Over the window. You know, with your aeronautical background, that we can now characterize boundary layers and flow fields including hypersonic flow fields, very, very well.

One of the things we have not done as much as we should have and we will need in this program is to be able to understand the optical qualities and how those change. That is why this experimental program is going on, to find those answers.

What we are finding is, and we are building models so that you can predict this as well, that in many cases you can see and see quite reasonably through this, but you must be able to ensure that as you are looking at it through the shock wave, it is that you do not get an angular distortion that is so large that it will cause you to miss with your guidance system.

Chairman GOLDWATER. The jet should not have any effect on the positioning of the missile on anything over mach 1?

General ABRAHAMSON. The jet that comes out still acts like a rocket. Therefore, it is a force that will allow you to maneuver.

Chairman GOLDWATER. But the boundary layer you are going through with mach anything will not stop the jet effect?

General ABRAHAMSON. Here you can see, in fact, the color boundary. Here is the shock wave coming up at the mach 8. The jet is firing. It is subsonic behind this.

[Chart not available.]

Therefore, the effect of the firing is causing some small impact here. You can see that, indeed, it does disrupt and change the character of the shock wave.

Now, you are correct, sir, that shock wave and change in the shock wave does not have a primary effect on the motion of the missile. We are trying to understand, if you can have effective maneuvering power generated by the jet and what that does to the optical quality.

Chairman GOLDWATER. Are you doing that work down at Arnold?

General ABRAHAMSON. Yes, sir. That is where some of it is being done. In fact, most of it is using the very high speed shock facility at Arnold.

Now, once again, you will recall, in one of the last charts that Mr. Gardner laid out we talked about satellites in space providing support in terms of being able to see and track missiles and track warheads.

A ground rule in the program is, so that we cannot be easily countered, that we do not want to do any one function in only one way because we do feel that the Soviets can find ways to deal with it.

So, one of our programs, and one that has taken a lot of criticism, is the airborne optical adjunct. This is an airplane platform now, and whether we use a drone in the future, an aircraft, or whatever we use, is another question.

The experiment is that you must be able to get the infrared telescope to be able to see out above enough of the atmosphere so that it will not be affected by it and to be able to see very accurately across hundreds of miles.

[Chart deleted.]

Here is one of those programs, one more time, the point I am trying to make is that we are attempting to demonstrate that we can build the system as early as possible, but before the 1990 timeframe.

In order to do that, we need to understand what missiles look like out of the atmosphere. We already know that in the atmosphere the flame pattern stretches out behind a missile and is contained.

In space the flame throws out and it becomes very difficult. We must ensure that we can take a satellite or an airplane that is a long ways away, see the infrared signature and then be able to direct a laser not at the infrared signature, but at the little teeny missile sitting above it.

Therefore, in this case we are using NASA facilities, what is called the Kyper Laboratory. It is an airplane with a very fine, in this case, an ultraviolet and infrared telescope.

We go out and we watch our own Minutemen launches and we are building technical models of this so that we can test.

Senator WARNER. General Abrahamson, have you had an opportunity to finish your direct testimony? If not, take as much time as you need.

General ABRAHAMSON. Sir, let me shift. I was really, and perhaps I overmade the point that there are several of the integrated experiments that we think are coming along, aimed at the early 1990 timeframe, that warrant confidence.

Let me move now to some of the lethality testing and meaning of that because, obviously, we have to know that these things cannot only build a weapon, but they are useful and some of the survivability issues.

[Chart deleted.]

Senator WARNER. Do any members desire to question the Secretary further? If not, I think we should let him leave.

Senator GORE. I had one additional question, Mr. Chairman.

Senator **Warner**. Mr. Wilson.

Senator **Wilson**. Mine can wait.

Senator **Warner**. Mr. Exon.

Senator **Exon**. I may have some questions, but he can answer them for the record.

Senator **Warner**. General, will you forebear while Mr. Gore propounds his questions to the Secretary?

Senator **Gore**. It is partly rhetorical, I fear, in response to the last question I posed about cost effectiveness, within the terms of your example, if we deployed a defensive system that cost $100 billion and the Soviets could overcome it with offensive improvements which cost them only $80 billion, your response was that they might not necessarily make that choice, they might choose to make those expenditures in other military equipment, perhaps tanks.

The question is, and it is not just rhetorical, I know that minds very seldom get changed in these sorts of discussions, but seriously, if the Soviet Union deployed a defensive system of $100 billion in cost which was capable of stopping a United States retaliatory strike and yet we could overcome that defensive capability by spending $80 billion, do you think we would choose to spend the $80 billion on tanks instead?

Mr. **Perle**. No, I do not, I think we could spend whatever it took to be sure that we have a retaliatory capability.

Senator **Gore**. Don't you think they would, too?

Mr. **Perle**. Absolutely. That is not what we are talking about. We are not talking about the Soviets maintaining a capacity to retaliate, but the Soviets retaining something a good deal more menacing; that is, the capacity to attack and destroy a significant element of our retaliatory capability.

That may be a Soviet objective. I do not know whether you share my view that this is their current objective, but it may be a Soviet objective that they may be persuaded to abandon.

Senator **Gore**. I think there are geopolitical consequences to the acquisition of such a capability by the Soviet Union. They believe there are geopolitical consequences attending the acquisition of such a capability by the United States.

Though it is widely implausible for any adversary to assume that we would ever launch a first strike, nonetheless, the geopolitical implications attendant to a possession of such a capability by the United States are deeply feared by the Soviet Union.

I do not think there is any question whatsoever, and I am surprised that there would be in your mind, about the fact that if we develop the ability to stop a Soviet attack of the level assumed in a retaliatory strike, so-called ragged retaliatory strike, I do not think there is any doubt whatsoever that the Soviet Union would spend whatever was necessary to make certain they could penetrate that defense, particularly if the cost of doing so was only 80 percent of the cost of erecting that defense in the first instance.

I do not think it is possible to take seriously an assertion that they would do anything other than that.

Senator **Wilson**. Mr. Chairman, may I interject a question?

Senator **Warner**. Perhaps the witness can respond first.

Senator **Wilson**. Let me give him a straight line.

Isn't that exactly the situation you are describing, the Soviets have been at this for years, they have been out-spending us. I am cheered by what I have heard today from General Abrahamson in terms of the progress which has been made.

Isn't Senator Gore's fear, in fact, what we are up against?

Senator GORE. If I could respond and then ask the witness to respond to the question as originally posed, I do not think that we have any doubt in our minds whatsoever that we can penetrate the current Soviet defenses. I do not think we are up against that situation now.

But if we deployed $100 billion defensive system, that while not effective against a Soviet first strike could nevertheless be quite effective against a ragged retaliatory strike of the kind that would remain theoretical due to our doctrine, but have the kind that would nevertheless pose severe geopolitical consequences for the Soviet Union, is there seriously any doubt in your very keen strategic mind that the Soviet Union would not spend whatever was necessary to make certain they retain the ability to penetrate that defense, particularly if the countermeasures were cheaper than the defensive system was to begin with, and thus ignite or accelerate or double the arms race in offensive and defensive?

Mr. PERLE. No, I do not think that can be taken as automatic.

Senator GORE. They would spend it on tanks.

Mr. PERLE. No. First, the cost to the Soviet Union in relation to cost to the United States has no bearing, in my view, on the Soviet decision. The fact that they may be able to purchase an ability to overcome defense for less than we have paid for that defense seems to me irrelevant.

The Soviets will have to measure, as they make a decision, the burden that acquiring that capability would impose on them, what they would have to give up in order to do it.

In theory, one can imagine breaking the bank, if you will. I am not suggesting that is our policy; it is not. But, to assume that the Soviets are in any way motivated by some assessment of the relative cost, I think misses the point.

These fellows do not sit in the Kremlin and say, "We will only build it if it is cheaper for us than the cost to the United States for the thing we are trying to get around."

There is no history or logic in that. It is an analytic device that I do not think applies appropriately to Soviet motivation. But the question you raise is an important question.

How would the Soviets respond if the United States began deployment of the strategic defense?

Here I think it depends fundamentally on whether the Soviets are prepared to accept a modest deterrent capability of the kind implied by the ABM Treaty and its associated agreements on nuclear forces, or whether they wish to possess a very sizable force that causes us to be concerned about the survivability and effectiveness of our retaliatory capability.

I cannot answer that question, but it seems to me implicit in the way you put the question is the judgment that the Soviets are bound and determined to maintain the sort of formidable offensive capability they now have.

I think also implicit in your formulation is the notion that the Soviets believe that the United States has or will have both the capability—that is, the technical capability—and the will to launch a first strike.

I do not happen to believe that. Or alternatively that with the capability we would threaten and intimidate the Soviet Union and derive some geopolitical advantage from that.

The Soviets have some history to go on here. In the period in which the United States possessed a nuclear monopoly, when it would have been easy to threaten and intimidate the Soviet Union, we did not do so. Nor have we done so in periods when we enjoyed significant advantages, but less impressive advantages than in the period when we possessed a monopoly.

While I certainly agree that there is ample fear on the Soviet side, I think they also make careful, calculated, rational analyses of our capability and the combination of offense and defense is not there.

Senator GORE. Mr. Chairman, may I encroach on the subcommittee's courtesy long enough to ask one more question?

Senator WARNER. Yes.

Senator GORE. Let me just say I think the history of the nuclear age demonstrates that capabilities are important as intentions, and possession of first strike capability generates fears and geopolitical implications, even absent intentions, which are difficult to establish by the adversary.

Let me ask a question about another thing.

Would the new U.S. position banning mobility prohibit our country from deploying the MX or even the Midgetman in a multiple protective shelter mode?

Would it prohibit the so-called carry-hard scheme?

And exactly what is the definition of mobile implicit in that new position?

Mr. PERLE. The details of that proposal have not been worked out, so I cannot answer that question now. Clearly it aims at eliminating on both sides weapons whose numbers are virtually impossible to verify.

You have to face up to that reality.

Senator GORE. I do not want to get into a debate on that. I just wanted it to be a narrow question because the debate would provoke an extensive exchange for which I do not have time and I appreciate the answer that you do not know at this time.

I appreciate the subcommittee's courtesy.

Mr. PERLE. I want to make one point. There is a great deal of question in my mind whether we will see Midgetman through to a conclusion.

I read the stories following the briefings on the proposal about consternation, including among members of this committee, that we would propose elimination of mobile ICBMs.

One of the factors that bore on that decision was the uncertain future of that program. The Congress could, if it wished to help, settle that issue by appropriation all the way through the deployment stage.

I do not think that is likely to happen. I am not sure we have the appropriate mechanism to do it. It would certainly bear on the way we think about the advantages for the United States of trading off the potential mobile missiles on our side for the reality of mobile missiles on theirs.

Senator GORE. If there were a question about the political survivability of the missile, one would have supposed the administration would have consulted with the allies that have worked 3 or 4 years on the question with them.

Nor did they consult with the Scowcroft Commission or the Deutsch Commission.

I do not want to get into it at this time because I am a guest here. I appreciate the committee's courtesy.

Mr. PERLE. I did want to convey the sense of the difficulty that any administration faces as it tries to put together a position, given the uncertainties about whether critical elements will be there during the lifetime of the agreement.

We predicated our negotiating position earlier on the MX. I am rereading Harold Brown's testimony in 1979 about the MX and SALT II. But these things change. We all know they do and for good reason.

It is awfully difficult to put a negotiating position together. These are easily criticized. I simply wanted to make the point that we have to make judgment about which no one can be certain, about how solid and reliable the thing on which one is depending will prove to be in the long run. We are not clairvoyant.

Senator WARNER. This Senator has been very quiet on the subject. I have concern because of the right and left turns of the country's strategic policy. I think the President is trying to do what he thinks is best in the interest of this Nation and our allies.

I want to give him all the support that we can.

Senator WILSON. Let me put on the record a request that at some future briefing, perhaps Tuesday would be appropriate—I think now it is inappropriate because it involves a higher clearance—I would like to have the subcommittee receive a briefing on the status of research being done by us with respect to Tinsley as a counterability.

It would be well if the subcommittee understood where we are as well as where the Soviets are.

Mr. PERLE. Mr. Chairman, I did not mean, and I want to be clear, the remarks I made about national disarray to suggest any partisanship.

I just came back from a NATO meeting where all of our allies gave very strong support to the President as he departs for Geneva. Some of those allies are not always towers of strength on some of our positions, but I think they recognize this is a critical moment and they perceive its usefulness.

We have plenty of time for our debate later. I appeal for the kind of solidarity that NATO expressed a week ago in Brussels.

Senator WARNER. Mr. Secretary, it is always nice to have you before the committee. We thank you for your patience this morning and for your very valuable contributions to the subject.

General Abrahamson, you have been a tower of patience.

General ABRAHAMSON. I would say, sir, this committee is very patient.

There is this general feeling about survivability and nonsurvivability. I would like to give you three examples of some of the thinking that is trying to wrestle this fundamental question of whether there is an inherently more survivable position or inherent advantage in being in space to the defense?

One of the concepts aimed at finding that out is [deleted].

[Deleted.]

If you do one additional thing, if that thing is not only just [deleted].

Therefore, what you have done with a simple [deleted] of the satellite.

Again, remember when this simple device is utilized, they will not know exactly where the satellite is [deleted].

Please notice I am calling this secret. It is because people are now beginning to work on these kinds of concepts, and come up with these protective measures, that I just flatly reject assertions that obviously, if it is in space, it can be stopped.

[Deleted.]

[Chart deleted.]

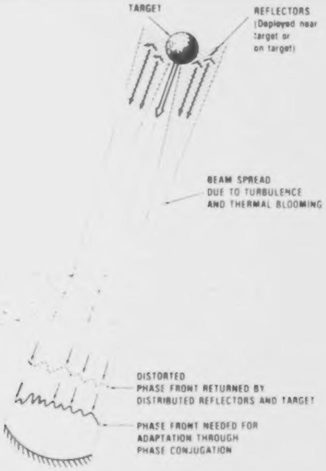
Now, the ground-based laser is the one that is troublesome for us. One way to protect a GBL is through the use of lenses, but there is something even simpler than that.

If you recall, I said that we have to be able to get the ground-based laser energy up through the atmosphere. If what you are firing at is your own mirror, that is going to project the laser forward, you have a cooperative target. That cooperative target and the means that we use to get up through the atmosphere, can send a laser signal down or a reflector on the target itself so that you can measure the kind of errors that the atmosphere introduces and then corrects it.

If it is an uncooperative target, instead of helping the computer and the mirror on the ground, what you want to do is very easily and simply put up things that will make that job difficult so that they cannot figure out exactly what correction they need for the atmosphere. This is a simple scientific principle.

Laser corner reflectors, just little devices out in space, cheap mirrors built in the shape of a triangle corner out here which are at different altitudes or in a layer ahead of this and it will disrupt what the computer is telling the mirror to correct on the ground.

CONCEPT FOR COUNTERING ADAPTIVE OPTICS
COMPENSATION FOR TURBULENCE AND THERMAL BLOOMING


TARGET
REFLECTORS (Deployed near target or on target)
BEAM SPREAD DUE TO TURBULENCE AND THERMAL BLOOMING
DISTORTED PHASE FRONT RETURNED BY DISTRIBUTED REFLECTORS AND TARGET
PHASE FRONT NEEDED FOR ADAPTATION THROUGH PHASE CONJUGATION

We will be doing experiments as early as we can to test the effectiveness of that.

Now, could they do that on the missile? No, because the missile is accelerating. Maybe they can invent some way to deal with that, but that is cheap and easy. I want to point out that we are dealing with it.

We are even working on what we consider to be perhaps the most dangerous of all of the technical concepts, the x-ray laser. If the Soviets develop an x-ray laser that has sufficient brightness and sufficient power, then that is a very, very effective weapon.

So, we have challenged our own people to say, is there some way that we can counter that particular weapon if they do that?

[Chart deleted.]

Some of our people have come up with a concept [deleted] kinds of things, but we are inventing and working with various kinds of concepts. They appear to be not only reasonable, but not terribly expensive.

Senator WARNER. Where do you think the Soviets might be on that x-ray laser?

General ABRAHAMSON. [Deleted.]

So, that is a difficult one. I just wanted to use these three. There are many other kinds of concepts that one can use. I do want to point out that here again some of the same weapons that can be very powerful against a missile traveling in space, there are means by which you can counter firing up at your weapon from the ground-based kind of laser and from other concepts.

These are not all final answers. I assure you this is a major effort in our program.

We are working very hard in lethality. We are doing things for a long period of time, lethality against rocket motors themselves and also against some of the materials that they build warheads out of it.

On September 6, 1985, the first laser lethality test was conducted for the Strategic Defense Initiative on the High Energy Laser System Test Facility (HELSTF) at the White Sands Missile Range, N.M. A full-scale station test was conducted to validate our technical understanding of the laser vulnerability of liquid propellant ballistic missile systems.

The test vehicle was the second stage of a Titan I booster missile body. External loads were applied to the booster to simulate flight conditions typical of current operational Soviet missile systems. The test vehicle contained no liquid propellant or explosives. It was irradiated with a high-energy laser beam for several seconds before being destroyed.

The laser used in this test was the large chemical laser, MIRACL (Mid-Infrared Advanced Chemical Laser). The MIRACL, the most powerful continuous wave laser outside of the Soviet Union, had been previously tested at HELSTF with its beam quality near the theoretical limit.

Operational details of this test are classified.

Official Department of Defense Photograph.
Washington, D.C.

September 17, 1985.

This is a very small laser and some early work where a laser has been used to first breach some of the composite materials and then after a breach, the material itself will just run.

So, there was at least one early test a long time ago.

There were other early tests and I have shown to this committee where we have used a Thor upper stage, pinned it down, and, remember, we are doing this within the treaty, and then fired a laser and tried to understand the dynamics of the structure and watch it collapse in a second or less.

It is easy to fire against a rocket, you get a lot of flame and smoke. We are not so interested in that. We know what happens when you fire against a rocket motor and you burn through and you ignite the system.

The tests that we have publicized are in fact important scientific tests. We did feel it was important to let people understand that we are making progress. These are early tests.

You know that we publicized several of these tests where we took a Titan missile or a section of a Titan missile. We strapped them down so that they felt the acceleration as they would have a missile going up in the boost phase and then using our one single large laser that we have, which is not a very good simulator, by the way, and did the same thing, did that in about [deleted] in this case.

[Chart deleted.]

Senator **WARNER**. At what range?

General **ABRAHAMSON**. Sir, this is in the atmosphere. This was about eight-tenths of a kilometer. Range is not the issue. What we are really experimenting with is what is the effect of the spot size and the spot intensity.

We know that we are not projecting across thousands of miles, which you could not do through the atmosphere. You have to get out of the atmosphere and then project.

Our job is not just a simple one of just blowing a few of these things apart. What we have done is based on earlier tests and computer models. We have come up with proper structures and different operating pressures. We have come up with a destruct line of laser energy where we know it should destroy itself and then we try to validate that as inexpensively as possible with one, two, or three selected tests.

Our first test was right on the line of our prediction. We were very pleased to see that it destroyed it. Then we moved down to a much lower operating pressure where in fact it should not have been destroyed and we found the same thing.

What we are finding is that pressurized rocket vehicles are more susceptible, they are more easily destroyed by laser energy of the kind that we are using here than we expected.

The reason I take time to show you this is that I do want to illustrate that this is a very thorough lethality kind of program that we are embarked on.

[Chart deleted.]

Here are some of the implications of that. You can say if your rocket is easily destroyed, a countermeasure that is often talked about is to put some kind of material on the outside of the rocket. A thin layer of something that would be difficult, ablative material or something of that kind.

Now we have gone into our own design [deleted.]

So, we are indeed trying in our analysis in our program to play this very interesting chess game so that we make the right choice. But it is not as easily done as the Union of Concerned Scientists itself, and others, simplistic kinds of answers that are thrown out, "Oh, all they have to do is mirror the surface or wrap some material around."

It is not that easy a job. If they do, it costs them something.

[Chart deleted.]

[Deleted.]

[Chart deleted.]

[Deleted.]

[Chart deleted.]

[Deleted.]

Could they do that to us? How can we avoid that kind of problem for us as well? Certainly we would not approve one of these weapons unless we know that it could be effective.

I would like to say that there are a lot of other technical benefits that grow out of this program. Let me briefly mention a couple.

We now have two automated production lines operating for gallium arsenide. Gallium arsenide is the next generation of electronics. We have only two automated production line operations. Funding in this program started, by the way, under an early DARPA program and now is funded entirely by this program.

SDIO/DARPA MESFET PILOT LINE

- **PILOT PRODUCTION CAPABILITY ESTABLISHED FOR GaAs LSI DIGITAL INTEGRATED CIRCUITS**
- **4K RAM AND 2K GATE ARRAYS DESIGNED FABRICATED AND TESTED**
- **16K RAM AND 6K GATE ARRAY IN DESIGN**

The only two automated production lines I know of in the free world except in Japan. We do not know yet what they are doing in Japan.

This is the next generation of electronic material. We believe that we are getting a good start on this kind of next generation of electronics. This is an invention, it has been done partly under other funding and now we are developing it. It is an invention of the Draper Lab at MIT where before we were making gyroscopes for airplanes, for missiles and for everything out of their complex machines, they have a large rotating mass and a lot of electronics.

[Chart deleted.]

We advanced to the next generation and we created a triangular laser called the ring laser gyro. We now have the next version of this which is nothing more than a little coil of fiber optics material.

In terms of like necessary and techniques, it will be applied not only to SDI, but for many kinds of contexts. It is just again an example of how we are pushing different kinds of technologies forward.

These are examples of the basic technology program.

This again has to do with being able to survive and operate in space. One of the reasons we are interested in gallium arsenide is because it is much more resistant to irradiation. [Deleted.]

We are not only working in gallium arsenide. Here we are taking an infrared focal plane and we have determined through testing that the particular way the material is laid out makes a major difference in its susceptibility to irradiation.

[Chart deleted.]

Let me show you the example. This is just a level of the signal that this particular infrared sensor can normally operate against. Here is its background and here is its signal.

If you irradiate that with radiation from a bomb, for example, what you have done is you have changed the background signal and you have changed the signal itself.

In other words, it has lost its ability to operate as a precise instrument. We do not know how it will operate. Creating a different geometry and putting certain kinds of materials in the right places in the system, we have now already shown, you can see in this trace the background of the signal and after irradiation no change whatsoever.

These are, frankly, things that really interest engineers that may not interest you a great deal, but I can assure you that the success of SDI may turn on some of these kinds of advances.

But also the success of some of our future weapons of many kinds, airplane and other systems, may also be significantly enhanced by these kinds of inventions.

With that, I will stop with my status report.

Senator WARNER. I think it has been an exceptionally rewarding hearing. We thank you.

General, I am going to ask at this juncture that Senator Wallop be allowed to ask his questions. He has attended the hearing. He has not had an opportunity to ask any questions.

The Chair recognizes him now for a period to ask questions.

Senator WALLOP. Thank you very much.

I guess I will ask Secretary Perle if technical capabilities that have been described here continue to move at the speed that they have, which is rather astonishing, here only 18 months after the Fletcher report, we are talking about a laser twice as powerful as envisioned by any of them after the year 2000, and it will be ready by 1990.

The question is: What reason is there that Americans are deprived of a defense that is technically available from the standpoint of strategic security, strategic ability, or any other reason?

Mr. PERLE. I believe that they should not be deprived of the defense system that is available. Obviously, we have to look at questions of cost. We want to be reasonably confident that the Soviets cannot easily overcome it, but a defense that can be effective, that is affordable, that cannot be easily defeated, would be, in our judgment, in our interest and we should proceed with it.

Senator WALLOP. I am a little disturbed by the fact that all of these decisions appear to be scheduled for 1990, 1991.

Whenever that moment in time comes, assuming an arms control agreement, in which we were to scale down both offenses and defenses, would we not just be prolonging and protracting world tensions and providing avenues of evasion that keep us in a state of less rather than more security?

Mr. PERLE. I would not say the arms control agreement prejudices the potential for deployment of defenses at levels sufficient to accomplish our purpose.

Obviously, we would like to see a reduction in offensive forces on both sides, but not at the expense of preventing ourselves from proceeding with promising strategic defense.

Senator WALLOP. Assuming something like that takes place, I am trying to get at the effect of such an agreement. Assuming we scale back both at the same time, it strikes me just observing, that we have done nothing to enhance the security of either ourselves or the other side since we made level the choice that is already frightening to us and is the reason we are entering into arms control negotiations.

In other words, if you minimize the capability to defend against these things while minimizing the numbers of them, you really wouldn't have done a whole lot for the establishment of the security of America.

Mr. **Perle**. I certainly agree it is possible to draft an agreement that so encumbers the defense that it would prevent you from making full use of the potential. We would not favor such an agreement.

Senator **Wallop**. I am suggesting that if there was a proposal that came either from some Member of Congress or the Soviet Union, or someplace, what would be the effect of such a thing?

I am just telling you what I think. I do not count myself as a strategy expert. If you lower both at the same time, both strategic offensive capability and the ability to defend against them, you would really have only frozen in place the level of tensions that currently exist and provided the means by which we would always have threatened breakout.

Mr. **Perle**. I understand the point you are making and I think that is quite right.

Senator **Wallop**. Let me ask one last question, Mr. Chairman.

Is any accelerations possible in any of these experiments, assuming a level of cooperation by Congress and a desire by the President to move them on?

General **Abrahamson**. The answer is yes. What we are being forced to do is that even though as we make decisions and select a particular technology and trying to fund individual technologies that most contribute to our capability as robustly as possible, there are some parallel technology efforts that are not going to work.

I am laying out a schedule and as we go through the research phase, we are going to find problems. If I had additional resources so that we could be carrying forward some parallel paths as the Apollo program had, and others, there is no question we could accelerate.

Senator **Wallop**. The cuts are critical not only from the standpoint of procedure, but expense as well?

General **Abrahamson**. Yes.

Senator **Warner**. Somehow in this record I want to have a discussion about allies, how we are dealing with them and what protection we have on exchanges of information.

Could you describe for me how long you and John Gardner, et al., would want to deal with that subject?

It is extensive and I feel we should schedule it for another opportunity.

General **Abrahamson**. Sir, we can give you brief answers but the kind of questions I know that the members of this committee would like to ask and the level of understanding that I think is appropriate, that you would probably like at least an hour or so, maybe more.

Senator **Warner**. We will arrange that and quite probably we will do it following the summit.

I think most of my questions can be provided for the record.

I will defer to my colleagues here if they have anything they feel they should ask.

Senator EXON. Mr. Chairman, I want to thank both these gentlemen for coming. It has been a tremendous informative session.

I had one question earlier that I said I wanted to ask. The chairman just touched on it. I do think it is more appropriate if we go into that in more detail in some session.

I have some concern about how much of this we are going to spread around to Europe. We are going to have to do that to satisfy them, I guess. They may have better security than we do here.

Also I have a question about how we are spreading this around in the United States. Will there be a hearing addressing this?

I thank you for your excellent presentation.

Senator WARNER. I think your question is well taken. Perhaps a hearing should be arranged around the framework of the substructure, both domestic and international.

General ABRAHAMSON. We will be happy to respond.

Senator WARNER. Now, Mr. Wilson.

Senator WILSON. Mr. Chairman, because of the lateness of the hour, I will limit my questions to just one.

You have commented in making the presentation, General, on certain restraints that have been imposed. This really deals with the question that Senator Wallop raised about the ability to accelerate and what constraints there are on us.

Can you provide the committee with a response as to what you would be doing with funding at a higher level and what acceleration that could achieve?

General ABRAHAMSON. I will be happy to respond to that. I would like to point out that there are really two.

One is if you can have a planned program and have sufficient resources to conduct that, there is a second one which is a very difficult problem. I saw it when I was asked to become a consultant to NASA on the space shuttle.

Perhaps the most devastating thing for any program is to plan it and get people started, have teams and aim at certain goals, and then have it cut back sufficiently that you have to greatly adjust, and you have to recover next year and you have to cut back again.

That second effect is very difficult to even measure, except in retrospect, how disruptive that is.

Senator WILSON. When you come back before us on the presentation dealing with the allies, I do not know whether it is appropriate, Mr. Chairman, or not, but I have a great interest in the ATBM aspect of this technology and at some point I would like to have a briefing on that.

Senator WARNER. I would accept that. Any member of the subcommittee can feel free to suggest any items for the agenda.

Mr. Gore, what are we waiting for?

Senator GORE. A very brief question from me. I see the chairman on his feet.

I would like to say briefly, by way of preface, General, although I have very definite concerns about this program, I have nothing but admiration for you and for Mr. Gardner and for your staff and I think our country is very fortunate to have a team like the one you have put in place to pursue this project vigorously and leave the policy questions to us.

You present the very best effort you can put together and it has been a very impressive one and you had answered questions candidly.

I really admire the work that you and your team have done. I think many of those who are concerned about SDI share the sentiments I have just expressed. So, keep up the good work.

I have a couple of brief questions, Mr. Chairman.

The first is about cost.

Now, these kinetic-kill vehicle platforms, how large are they? One shuttle load?

General ABRAHAMSON. The kinetic-kill vehicle, also one that would be put in space would hopefully be very, very small.

Senator GORE. The platform?

General ABRAHAMSON. It depends on what we finally designed. If you put a hundred of these smaller missiles in one platform, then, yes, it might add up to a shuttle load.

If, on the other hand, it becomes more survivable by putting only 10, you might be able to put 10 in a shuttle.

Senator GORE. The baseline now, as I take it, is 20 to 30 projectiles on each platform. Now, the platform that is capable of being survivable and accurately launching 20 to 30 of these little projectiles is a pretty big platform up there; is that correct?

Does it have computer capability in space?

General ABRAHAMSON. Yes, it has to be able to be basically aimed in a rough way.

Senator GORE. Is it a fair consumption that a platform of this complexity, of this size, of this sophistication, capable of having that computer capacity and aiming, deploying and launching vehicles and knocking down ICBM's, it is fair to assume that a platform of that kind would cost at least as much as one of our [deleted] satellites today [deleted].

General ABRAHAMSON. No, sir, I do not think that it is.

Senator GORE. It would be cheaper than a [deleted] satellite that cannot do any of those things?

General ABRAHAMSON. Yes, sir.

Senator GORE. Tell me why that is the case.

General ABRAHAMSON. Some of the present very complex satellites that we use have a tremendous computer requirement.

They also have [deleted] requirements that are very, very complex. What we are talking about essentially is a rocket fired in the sky and some syabilization for it and enough computer and communications capability that you can cause it to effectively be aimed and aimed quickly.

Let me use one example and I am sorry, I could not bring a model of some of these things right now, we can now, and will be much better in a few years, take a laser communicator, which is about that big, and put it on the satellite and be able to transmit millions of bits of information in a very, very short time in a way that the Soviets cannot interfere with it. I do not know the cost of that.

Senator GORE. I understand. Let me make sure that the Chairman is on track with the point that I am making with this question.

We have a new platform going up in space that has sophisticated computer capability and capability to launch 20 to 30 projectiles, the capability to evade and/or survive attack, and the cost projections are that it will cost one-tenth of 1 percent as much as the present generation of [deleted] satellites.

General ABRAHAMSON. I do not know where you got that.

Senator GORE. You used the figure of $1 million.

General ABRAHAMSON. No. That was for the kinetic-kill vehicle itself.

Senator GORE. That is for the projectile?

General ABRAHAMSON. For the projectile.

Senator GORE. What is your estimate for the platform?

General ABRAHAMSON. At this point we have not made a good firm estimate.

Senator GORE. Is $1 billion a fair estimate?

General ABRAHAMSON. That is much too expensive. In fact, the whole thrust of this program is that we must find ways to bring down the cost of these systems. In fact, one of the major efforts that is causing a great deal of difficulty in the space community and for myself is that what I am talking about is that we will not build satellites the way we build satellites today. They are built individually. They are built with a great number of people doing a lot of different kinds of tests.

We will have to be able to build these like they were a product line.

Senator GORE. If one of these platforms costs as much as the present generation of satellites, then the cost of this component alone would be on the order of $1½ trillion.

General ABRAHAMSON. The answer is if it even approaches the cost of something like that, we will have failed and I would never go for a recommendation that that kind of system should be included.

Senator GORE. I have a lot of faith in you, General, and I hope you keep up the good work, but my faith has limits in this particular area. If anybody can do it, you can.

Thank you, Mr. Chairman. I am sorry to take so long.

Senator WARNER. We are glad to have members of the Senate avail themselves of the opportunity to come visit with our distinguished witnesses.

[Questions for the hearing record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

ABM TREATY AND "EXOTIC" TECHNOLOGIES

Senator WARNER. Do Soviet strategic defense programs provide any insights into the way they have interpreted the ABM Treaty's limitations on exotic technologies, such as lasers?

Mr. PERLE. Soviet programs for anti-ballistic missile and space defense, which include advanced technologies and spacebased weapons, were in place prior to the signing of the 1972 ABM Treaty. In fact, Soviet emphasis on the necessity of research into defense against ballistic missiles was demonstrated by then-Minister of Defense Grechko shortly after the signing of the ABM Treaty, when he told the Soviet Presidium that the treaty, "places no limitations whatsoever on the conducting of research and experimental work directed toward solving the problem of defending the country from nuclear missile strikes." Therefore, the Soviets never had the slightest intention, notwithstanding the existence of the ABM Treaty, of abandoning the search for strategic defense of both the sort that were available at the time and what was then considered exotic systems, systems based on other physical principles.

SOVIET STRATEGIC DEFENSE PROGRAMS.

Senator WARNER. The administration's recent publication on Soviet Strategic Defense Programs makes it clear that the Soviets have been aggressively pursuing their own strategic defense programs for many years—well before the President's 1983 speech. What is the military significance of these activities for the United States?

Mr. PERLE. The Soviet Union has an extensive operational strategic defensive network which dwarfs that of the United States as well as an active research and development program in both traditional and advanced defenses against ballistic missiles. Soviet offensive and defensive force developments pose a serious challenge to the West. If left unchecked, they would seriously undermine our ability to retaliate effectively in case of Soviet attack. The situation would be even more severe if the Soviet Union were to have a monopoly on advanced defenses against ballistic missiles in addition to its sizable offensive and conventional defensive forces. The SDI program is a prudent and necessary response to the ongoing extensive Soviet anti-ballistic missile effort, including the existing Soviet deployments under the ABM Treaty. The SDI provides a necessary and powerful deterrent to any near-term Soviet decision to expand rapidly its ABM capability beyond that permitted by the ABM Treaty.

INTERPRETATION OF THE ABM TREATY

Senator WARNER. In its recent decision regarding the interpretation of the ABM Treaty as it relates to exotic technologies, has the administration created a "double standard" whereby the Soviet Union is free to pursue their own strategic defense programs in a more aggressive manner than we are permitting for ourselves?

Mr. PERLE. No. Both the United States and the Soviet Union, as signatories to the ABM Treaty, have the legal right to test and develop ABM systems and components "based on other physical principles." As a matter of U.S. policy, however, the President has decided that we will continue to conduct the SDI research program on the basis of the more restrictive interpretation of the ABM Treaty.

X-RAY LASER PROGRAM

Senator WARNER. Would you comment on the recent press reports about the problems that are being experienced in the x-ray laser program?

General ABRAHAMSON. Recent newspaper articles imply that significant differences of opinion exist among the Department of Energy (DOE) laboratory scientists regarding x-ray laser experiment designs and attendant experiment measuring instrumentation. We believe that diverse scientific opinion, technical peer review and acknowledgment of honest technical disagreement among scientists is healthy and is encouraged. We have received testimony that the SDI research activities in the Department of Energy (DOE) laboratories comprise a state-of-the-art program which requires new inventions in most experiments. These experiments are highly complex, are carefully planned and carefully executed. Historically, for the research, development and testing (RD&T) of any new nuclear system, many underground tests are required to incorporate the learning derived from previous experiments. One experiment out of many on a test does not provide all the answers to a problem and may, in fact, raise more questions.

LLNL and LANL staff provide a continuing peer review for each other on all nuclear weapons RD&T, based on scientific and technical criteria. In addition, the University of California scientific and academic advisory committee regularly reviews both laboratories RD&T programs as a part of a routine management oversight function. The track records of Lawrence Livermore National Laboratory (LLNL) and Los Alamos National Laboratory (LANL) on the development of nuclear weapons and associated state-of-the-art technologies is unparalled in history, vital to our national security and, with Congress' support, we expect that trend to continue. There is also Department of Defense Review both through the program office and organizations such as the JASON's.

There are countless articles in the media on strategic defense and many have reported erroneous or misleading information. We do not think it would be useful to allow columnists through their newspapers to advise the Congress or Strategic Defense Initiative (SDI) scientists on the resolution of any high technology problems.

We do not view any scientific differences of opinion on SDI technology issues in the DOE laboratories to be a political issue and enthusiastically support the present research program.

Senator **Warner**. Gentlemen, thank you for your presence. The hearing is adjourned.

[Whereupon, At 1:08 p.m., the subcommittee adjourned, subject to the call of the Chair.]

STRATEGIC DEFENSE INITIATIVE

THURSDAY, NOVEMBER 21, 1985

U.S. SENATE,
SUBCOMMITTEE ON STRATEGIC AND
THEATER NUCLEAR FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

ABM TREATY LIMITATIONS

The subcommittee met, pursuant to notice, at 2:10 p.m., in room SR-232A, Russell Senate Office Building, Senator John W. Warner (chairman) presiding.

Present: Senators Warner, Cohen, Quayle, Wilson, Nunn, Hart, Levin, and Bingaman.

Staff present: Robert F. Bott, professional staff member; Arnold L. Punaro, staff director for the minority; and Jeffrey H. Smith, minority counsel; Robert G. Bell, Douglas R. Graham, William E. Hoehn, Jr., and George K. Johnson, Jr., professional staff members; Colleen M. Getz and Russell C. Miller, research assistants; and Karen A. Love, staff assistant.

Also present: Robert P. Savitt, assistant to Senator Cohen; James M. Bodner, assistant to Senator Cohen: Henry D. Sokolski, assistant to Senator Quayle: Mark J. Albrecht, assistant to Senator Wilson; Allan W. Cameron, assistant to Senator Denton; Janne E. Nolan, assistant to Senator Hart; John B. Keeley, assistant to Senator Levin; and Edward McGaffigan, Jr., assistant to Senator Bingaman.

OPENING STATEMENT BY SENATOR JOHN W. WARNER, CHAIRMAN

Senator WARNER. The subcommittee meets in open session this afternoon to receive testimony from administration and public witnesses on the implications of the ABM Treaty for the President's Strategic Defense Initiative [SDI] Program.

This is the fourth in a series of hearings that the subcommittee is conducting on the SDI Program, and several more hearings are being scheduled for after the Thanksgiving recess. We purposely planned it that way in order to receive information on the summit, thus enabling us to understand how the SDI Program has impacted on our arms reduction efforts.

The ABM Treaty limitations on exotic technologies have received heightened attention of late. This attention has resulted from the administration's review of the ABM Treaty text and the accompanying negotiating record, and their subsequent conclusion that the understanding of the ABM Treaty limitations on exotic technologies that we have recognized for over a decade was not supported by those documents.

Last month the administration announced that a more permissive interpretation of the ABM Treaty limitations on exotic technologies had a legal foundation. However, the President made a policy decision that the SDI Program would continue to be pursued in accordance with the more "restrictive" interpretation of the ABM Treaty.

The subcommittee intends to explore the implications of this policy decision on the SDI Program with its Director, General Abrahamson, and others. Today, however, we will be focusing on the legal aspects of the administration's recent decision.

Our first witness this afternoon is Judge Abraham Sofaer, the Legal Adviser to the Department of State. Judge Sofaer will explain the basis for the administration's conclusion that a broader interpretation of the ABM Treaty limitations on exotic technologies is with legal foundation. His presentation will be followed by a brief round of questions.

Judge Sofaer, I would like to welcome you on behalf of the subcommittee.

Judge Sofaer's presentation will be followed by a second panel consisting of Ambassador Gerard Smith who represented the United States in negotiating the ABM Treaty and the SALT I interim agreement, and John B. Rhinelander, who served as a member of the SALT I delegation.

I would also like to welcome you both on behalf of the subcommittee.

After the opening comments of my colleague from Colorado, Senator Hart, we can proceed with Judge Sofaer's presentation.

Senator Hart.

Senator **Hart**. Thank you, Mr. Chairman. I have no statement.

Senator **Warner**. Senator Levin.

Senator **Levin**. No.

Senator **Warner**. Senator Wilson.

Senator **Wilson**. No.

Senator **Warner**. Please proceed, Judge Sofaer.

STATEMENT OF JUDGE ABRAHAM D. SOFAER, LEGAL ADVISER TO THE DEPARTMENT OF STATE

Judge **Sofaer**. Mr. Chairman, this is my first appearance before the subcommittee. I am honored to be here.

I would ask that my written statement, which I have submitted to the subcommittee, be made a part of the record. In this way I will be able to summarize it.

I will spend some time, Mr. Chairman, with your permission, on some of the specific provisions of the treaty. I think when we discuss the meaning of the treaty and what aspects of the treaty are enforceable, it is very important to focus on the document and the language of the various provisions in that document, as well as on the negotiating history.

So, if you will bear with me, Mr. Chairman, I will spend some time on some of the specific provisions.

The treaty is an important element of our strategic arms control structure and we have conducted the SDI program, as you know, consistent with a "restrictive" interpretation of the treaty, as it has been referred to here.

Soviet violations of the treaty, the implementation of our SDI program, and the ongoing arms negotiations at Geneva recently caused various agencies to consider more thoroughly than ever before the appropriate interpretation of the ABM Treaty insofar as it relates to so-called future systems. By that, I mean defensive systems that serve the same functions as ABM systems and components, but that use devices based on technology not understood in 1972 when the treaty was negotiated and devices that are also capable of substituting for ABM interceptor missiles, launchers and radars.

This examination has led to the conclusion that a reading of the ABM Treaty that would allow the development and testing of such systems based on physical principles other than those understood in 1972 is wholly justified.

I want to emphasize the critical point made by Secretary Shultz in his speech to the North Atlantic Assembly on October 14 that:

> Our research program has been structured, and, as the President has reaffirmed, will continue to be conducted in accordance with a restrictive interpretation of the Treaty's obligations.

The Secretary also assured our NATO allies of this fact. I was with him at the time, Mr. Chairman, so I can testify to that—and he assured them also that they would be consulted before any major change was made in the program.

I was well aware when I began this work on the treaty and its meaning that several distinguished officials associated with the SALT I negotiation, and others still in the Government, had advanced the view that the ABM Treaty is unambiguous in its treatment of future systems.

They argued that article V of the treaty forbids development, testing or deployment of any future ABM systems and components other than those that are fixed land-based. They read Agreed Statement D as relevant only to fixed land-based systems and components, arguing that it permits "creation" of such systems and components when they are based on "other physical principles," but conditions their deployment on agreement between the parties on specific limitations.

Others in the administration were contending, however, that this restrictive interpretation was based on unilateral assertions by U.S. negotiators, that the treaty is in fact ambiguous, and that the negotiating record supports a broader view of our freedom to develop, test and even to deploy future systems.

My study of the treaty led me to conclude that its language is in fact ambiguous and can more reasonably be read to support a broader interpretation. The restrictive interpretation rests on the premise that article V(1) is clear on its face—that it says no development, testing or deployment of ABM systems or components other than those that are fixed land-based, and that this statement means any system or component or other device that serves the function of ABM systems as defined in article II.

But this language, "ABM system or components," that is found in article V does not settle the issue of the article's applicability to future systems or components. That issue depends on the meaning of the term "ABM system or components."

Is that phrase limited to systems and components based on then-current technology, or does it also include those based on future technologies?

In attempting to answer this question, one must turn to the definition actually provided of an "ABM system" in article II(1). Proponents of the restrictive view contend that the definition is purely functional—that anything ever conceived that could serve the function of countering strategic missiles in flight must fall within the definition.

These persons argue that the three components identified in article II(1), missiles, launchers and radars, are merely listed as the elements that an ABM system currently consists of, and that all future components of a system that satisfies the functional definition are also covered by article II(1).

It is this definition of ABM system or components that the proponents of a restricted view must have in order to have article V(1) mean what they say it means.

I would suggest that, while this reading is plausible, it is not the only reasonable reading, and in fact it has serious shortcomings. The premise that article II(1) defines "ABM system" in a functional manner, meant to include all future systems and components, is difficult to sustain.

The provision can more reasonably be read to mean that the system contemplated by the treasury are those that serve the functions described and that currently consist of ballistic components.

The treaty's other provisions consistently use the phrases "ABM system" and "components" in contexts that reflect that the parties were referring, in using those terms, to systems and/or components based on known technology.

I will skip over the few examples I gave in my written testimony, Mr. Chairman; there are many others in the treaty. Every time the words "ABM system" or "components" are used in the treaty, it is clear that the writer had in mind those conventional systems and components that were known and based on what would then be present physical principles.

Systems and components based on future technology are not discussed anywhere in the treaty other than in agreed statement D. In that provision, the parties felt a need to qualify the term "system and components created in the future," which appeared in agreed statement D, with the additional phrase "based on other physical principles."

If "ABM system and component" actually meant all systems or devices that could serve an ABM function, whether based on present or future technology, the parties would not have needed to qualify these terms in agreed statement D. That this qualification was added suggests that the definition of "ABM system" and "components" in article II(1) extended only to those based on presently utilized physical principles and not on "other" ones.

The existence of agreed statement D itself poses a fundamental problem for the restrictive view. Nothing in that statement suggests that it applies only to future systems that are fixed land-based.

On the contrary, it addresses all ABM systems and components that are "based on other physical principles." Moreover, the restrictive interpretation would render this provision, agreed statement D, superfluous.

If article II(1) extended to all ABM systems and components based on present as well as on future technology, then article III implicitly would have banned all future fixed land-based systems and components.

As you have seen in the treaty itself, Mr. Chairman, article III says that all systems and components other than those dealt with in article III are banned. So, agreed statement D itself would have been unnecessary.

An interpretation of a treaty, just like any other contract, which renders a portion of that treaty superfluous violates accepted canons of construction. The serious difficulties of construction created by the restrictive reading are avoided if one reads article II(1) and V(1) as referring only to ABM systems and components based on currently utilized physical principles.

Read in this manner, the treaty establishes a coherent, nonredundant scheme that prohibits:

First, the deployment of all fixed land-based systems and components derived from current technological principles except as specifically permitted in article III.

Second, the deployment, testing and deployment of all mobile systems and components derived from current technological principles, as is provided in article V(1).

And third, the deployment of all forms of systems and components derived from other physical principles until after agreement on specific limitations, as provided in agreed statement D.

Other reasonable constructions of this treaty have been advanced within the administration, Mr. Chairman, I might say some even broader than the construction that I feel is the correct and most reasonable construction and which the President has adopted.

Under international law, there is no need to go into those because my primary task in looking at the treaty was to determine whether it was ambiguous. It is clear to me that not only can it be read two ways, it can be read as many as four ways.

Now, under international law, just as is true under U.S. domestic law, once an agreement has been found ambiguous, one must seek guidance in the circumstances surrounding the drafting of the agreement.

In the present situation once we concluded the treaty was ambiguous, we looked at the negotiating record. That was no easy task. No one had collected the negotiating record in one single place. The one set of excerpts from the negotiating record that had been collected by some people within the administration was incomplete, seriously incomplete.

Senator **Warner**. We have an obligation to vote. We will vote as a group and return. We will resume as soon as both Senator Hart and I return to the hearing room.

Senator HART. I was wondering on that point: what is the administration's position in making that negotiating record available to the committee?

Judge SOFAER. Senator Hart, as soon as a formal request is made of some kind, that would trigger the administration's responsibility. I am not authorized to make the response.

Senator HART. Who is?

Judge SOFAER. I am sure it would go up the normal channels.

Senator HART. And stop where?

Judge SOFAER. Ultimately if need be, it goes to the President. I do not anticipate any such problem if such a request is made. I would urge you to consider——

Senator WARNER. We are going to be advised by counsel here who has some knowledge on this.

We will vote now and then return.

[Recess.]

Senator WARNER. The hearing will resume.

Senator Hart, in the interim I spoke to the judge. He would like to amplify some of his response with respect to the understanding of the procedure by which the Senate can acquire access to these confidential documents.

Judge SOFAER. I had no desire to amplify beyond saying that a letter from the committee to the Secretary would be an appropriate manner in which to trigger a formal request.

I would just remind you that this is a very special area, that is, the negotiating record of a treaty. It is not only classified, but generally very sensitive, closely held, and there are established methods for the executive branch to communicate to the legislative branch any materials that it wants through closed hearings and the observer process.

Ambassador Nitze and I appeared before the Senate observers 2 weeks ago. We were as forthcoming, I think, then as we were asked to be.

Senator HART. The issue is Congress' right and the obligation of the Senate to ratify treaties. We handle classified documents all the time.

Judge SOFAER. Absolutely.

Senator HART. Thank you.

Senator WARNER. Any further inquiry on this matter?

If not, we will return to the Judge's presentation.

Judge SOFAER. I just want to say one of the things you will find we have done is that we have collected now all the parts of the negotiating history that we could find that are relevant to this question in one place.

The prior collections themselves were inadequate and incomplete. So, some of the confusion in this area I would attribute to the fact that no one had properly collected the entire negotiating record. The record is classified, as you know——

Senator WARNER. That collection was completed before the various persons made their interpretations on this treaty?

Judge SOFAER. It was completed before I gave the Secretary and President my view of the treaty.

Senator WARNER. You had full access to it. You said, "Other persons have reasonable views, some of them broader than my own."

Did they likewise have access?

Judge SOFAER. All of them had access within the executive branch. The question is who has gone and done the digging and pulled it all together. The record was spread out in a variety of offices.

Senator HART. I think some of the people who we will hear from shortly may not agree with how the administration formed the record.

Judge SOFAER. Also, some of them who agreed with it also formed the record. Anyway, my examination, Mr. Chairman, after reviewing all the significant statements and drafts from the available negotiating history is that, although the United States delegates initially sought to ban development and testing of non-land-based systems or components based on future technology, the Soviets refused to go along, and no such agreement was reached.

The Soviets stubbornly resisted United States attempts to adopt in the body of the treaty—as a matter of fact, in what would have been article V, any limits on such systems or components based on future technology. Their arguments rested on a professed unwillingness to deal with unknown devices or technology.

The farthest the Soviets were willing to go with respect to such future systems or components was to adopt a side agreement prohibiting only the deployment of such systems and components, once created, until the parties agreed on specific limitation. The parties did not agree to ban development and testing of such systems or components whether on land or in space.

The negotiating record also contains strong support for a reading of article II(1) that restricts the definitions of "ABM system" and "components" to those based on current physical principles. The Soviets specifically sought to prevent broad definitions of these terms, and our negotiators acceded to their wishes.

Moreover, our negotiators ultimately convinced the Soviets to adopt agreed statement D by arguing that, without it, the treaty would leave the parties free to deploy systems or components based on other physical principles, such as lasers.

I am aware that some of the people who served as U.S. negotiators in those talks assert that they did achieve a total ban on the development, testing, and deployment of all future mobile systems and components, including those based on other physical principles.

The negotiating history contains suggestions as to why they reached their conclusion, but the record of the negotiations fail to demonstrate that they actually succeeded in achieving their objective.

On the contrary the record reflects that they failed to obtain the ban they sought and that we could never have enforced such a ban against the Soviets. Treaties, like other agreements, are enforceable only to the extent they create mutual rights and duties.

In effect, because the Soviets succeeded in avoiding a broad binding commitment regarding development and testing of mobile systems and components based on future technology, we cannot properly be said to be bound by such a commitment.

I wish to close by reiterating a critical point: That, notwithstanding our belief in the merits of the broader interpretation, the President has decided to pursue the SDI Program as currently structured, which can be accommodated within the confines of the restrictive interpretation, namely, research into, but not development or testing of, systems or components based on future technology and capable of substituting for ABM interceptors, launchers, or radars.

Thank you, Mr. Chairman.

[The prepared statement of Judge Sofaer follows:]

PREPARED STATEMENT OF ABRAHAM D. SOFAER, LEGAL ADVISER, U.S. DEPARTMENT OF STATE

Mr. Chairman, and Members of the Committee: This is my first appearance before your Committee. I am honored by your invitation to discuss the meaning of the Anti-Ballistic Missile Treaty with respect to so-called future ABM systems or components, including some contemplated as part of the Strategic Defense Initiative.

The ABM Treaty is an important element of our strategic arms control structure. When the President first announced the SDI program in March 1983, he made clear that it would be conducted "consistent with our obligations [under] the ABM Treaty." This commitment has been maintained. The United States has scrupulously complied with the Treaty, notwithstanding such clear Soviet violations of it as the Krasnoyarsk radar station.

Soviet violations of the ABM Treaty, the implementation of our SDI program, and the ongoing arms negotiations at Geneva recently caused various agencies to consider more thoroughly than ever before the appropriate interpretation of the ABM Treaty as it relates to future or "exotic" systems. By that, I mean defensive systems that serve the same functions as ABM systems and components, but that use devices based on technology not understood in 1972 when the Treaty was negotiated and that are capable of substituting for ABM interceptor missiles, launchers, and radars. This examination has led to the conclusion that a reading of the ABM Treaty that would allow the development and testing of such systems based on physical principles other than those understood in 1972 is wholly justified.

At the same time, however, I want to emphasize a critical point made by Secretary Shultz in his speech to the North Atlantic Assembly on October 14: "[O]ur SDI research program has been structured, and, as the President has reaffirmed, will continue to be conducted in accordance with a restrictive interpretation of the Treaty's obligations." Secretary Shultz assured our NATO allies of "[o]ur commitment to pursue the program as currently structured, which is consistent with a restrictive interpretation of our obligations under the ABM Treaty." Accordingly, he described the debate over the two interpretations as "moot." The issue may have practical significance only when the SDI program has reached the point at which questions regarding the feasibility of strategic defense have been answered and engineering development, with a view to deployment, becomes a real option.

I was well aware when I began my work on this issue that several officials associated with the SALT I negotiations, and others still in the Government, had advanced the view that the ABM Treaty is unambiguous in its treatment of such future systems. They argued that Article V of the Treaty forbids development, testing, or deployment of any future ABM systems and components other than those that are fixed land-based. They read Agreed Statement D as relevant only to fixed land-based systems and components, arguing that it permits "creation" of such systems and components when they are based on "other physical principles," but conditions their deployment on agreement between the parties on specific limitations. Other persons were contending, however, that this "restrictive" view of the ABM Treaty is based on unilateral assertions by U.S. negotiators; that the Treaty is ambiguous; and that the negotiating record supports a broader view of our freedom to develop, test, and deploy future systems.

My study of the Treaty led me to conclude that its langauge is ambiguous and can more reasonably be read to support a broader interpretation. An examination of the three provisions primarily at issue will demonstrate why this is so. Article II(1) defines an "ABM system" as "a system to counter strategic ballistic missiles or their elements in flight trajectory, currently consisting of" ABM interceptor missiles, ABM launchers, and ABM radars. Article V(1) provides that the parties agree "not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based." Agreed Statement D, a side agreement that accompanies the treaty, provides as follows:

"In order to insure fulfillment of the obligation not to deploy ABM systems and their components except as provided in Article III of the Treaty, the Parties agree that in the event ABM systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars are created in the future, specific limitations on such systems and their components would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the Treaty."

The restrictive interpretation rests on the premise that Article V(1) is clear on its face: it says no development, testing, or deployment of "ABM systems or components" other than those that are fixed land-based. But this language does not settle the issue of the article's applicability to future systems or components. That issue depends on the meaning of the term "ABM systems or components": is that phrase limited to systems and components based on then-current technology, or does it also include those based on future technology?

In attempting to answer this question, one must turn to the definition of "ABM system" in Article II(1). Proponents of the restrictive view contend that this definition is functional: anything ever conceived that could serve the function of countering strategic missiles in flight falls within the definition. These persons argue that the three components identified in that paragraph—missiles, launchers, and radars—are merely listed as the elements that an ABM system "currently consist[s] of," and that all future components of a system that satisfies the functional definition are also covered by Article II(1). Only when armed with these meanings can proponents rely on Article V(1) as a ban on development, testing, and deployment of all non-fixed land-based systems or components, whether current or future.

This reading of the Treaty is plausible, but it is not the only reasonable reading; on the contrary, it has serious shortcomings. The premise that Article II(1) defines "ABM system" in a functional manner, meant to include all future systems and components, is difficult to sustain. The provision can more reasonably be read to mean that the systems contemplated by the Treaty are those that serve the functions described and that currently consist of the listed components. The Treaty's other provisions consistently use the phrases "ABM system" and "components" in contexts that reflect that the parties were referring to systems and components based on known technolgoy. Article II(2), for example, further describes the "ABM system components listed in paragraph 1 of this Article" to include those that are operational, being tested, under construction, etc.—thereby indicating that the definition in Article II(1) was not merely illustrative, but was intended to describe the actual components covered by the Treaty. To take another example, Article V(2) sets limits on the types of "launchers" that may be developed, tested, or deployed—thus reflecting, in the same article as the alleged prohibition on future mobile systems and components, an exclusive concern for one of the current components listed in Article II(1).

Systems and components based on future technology are not discussed anywhere in the Treaty other than in Agreed Statement D. In that provision, the parties felt a need to qualify the term—systems and components created in the future—with the phrase "based on other physical principles." If "ABM system" and "components" actually meant all systems or devices that could serve ABM functions, whether based on present or future technology, the parties would not have needed to qualify these terms in Agreed Statement D. That this qualification was added suggests that the definitions of "ABM system" and "component" in Article II(1) extended only to those based on presently utilized physical principles and not on "other" ones.

The existence of Agreed Statement D poses a fundmental problem for the restrictive view. Nothing in that Statement suggests that it applies only to future systems that are fixed land-based; on the contrary, it addresses all ABM systems and components that are "based on other physical principles." Moreover, the restrictive interpretation would render this provision superfluous. If Article II(1) extended to all ABM systems and components, based on present as well as on future technology, then Article III implicitly would have banned all future fixed land-based systems and components. Such an interpretation, by rendering a portion of a treaty superfluous, violates accepted canons of construction.

The serious difficulties of construction created by the restrictive reading are avoided if one reads Articles II(1) and V(1) as referring only to ABM systems and components based on currently utilized physical principles. Read in this manner, the Treaty establishes a coherent, non-redundant scheme that prohibits:

The deployment of all fixed land-based systems and components derived from current technological principles, except as specifically permitted (Article III);

The development, testing, and deployment of all mobile systems and components derived from current technological principles (Article V(1)); and

The deployment of all forms of systems and components derived from "other" physical principles, until after agreement on specific limitations (Agreed Statement D).

Other reasonable contructions of the Treaty have been advanced, but the arguments I have presented amply demonstrate the ambiguities present in the text of the ABM Treaty.

Under international law, as under U.S. domestic law, once an agreement has been found ambiguous, one must seek guidance in the circumstances surrounding the drafting of the agreement. Thus, in the present situation, once we concluded that the Treaty is ambiguous, we turned to the negotiating record to see which of the possible constructions most accurately reflects the parties' intentions.

Examining the negotiating record for the ABM Treaty presented some real, albeit mundane, difficulties. No single agency has systematically collected and preserved the entire record in a readily usable form. My staff and I therefore obtained from various sources everything that we could find that might be relevant to thre issue of future systems and components. Although I cannot be certain that we have uncovered every single document that might be relevant, I can say with confidence that a much stronger case exists in the record for the broader interpretation of the Treaty than for the restrictive interpretation.

The entire negotiating record is classified, and I therefore cannot reveal any detail in open session. If, after this public session, the Committee chooses to go into executive session, I will be free to explain much more. I can tell you in general, however, that I personally reviewed all the significant statements and drafts in the available negotiating history regarding future systems. I reached the firm conclusion that, although the U.S. delegates initially sought to ban development and testing of non-land-based systems or components based on future technology, the Soviets refused to go along, and no such agreement was reached. The Soviets stubbornly resisted U.S. attempts to adopt in the body of the Treaty any limits on such systems or components based on future technology; their arguments rested on a professed unwillingness to deal with unknown devices or technology. The farthest the Soviets were willing to go with respect to such future systems or components was to adopt a side agreement prohibiting only the deployment of such systems and components, once created, until the parties agreed on specific limitation. The parties did not agree to ban development and testing of such systems or components, whether on land or in space.

The negotiating record also contains strong support for a reading of Article II(1) that restricts the definitions of "ABM system" and "components" to those based on current physical principles. The Soviets specifically sought to prevent broad definitions of these terms, and our negotiators acceded to their wishes. Moreover, our negotiators ultimately convinced the Soviets to adopt Agreed Statement D by arguing that, without it, the Treaty would leave the parties free to deploy systems or components based on other physical principles, such as lasers.

I am aware that some of the people who served as U.S. negotiators in the SALT I talks assert that they acheived a total ban on the development, testing, and deployment of *all future* mobile systems and components, including those based on other physical principles. The negotiating history contains suggestions as to why they reached their conclusions. But the record of the negotiations fails to demonstrate that they actucally succeeded in achieving their objective. On the contrary, the record reflects that they failed to obtain the ban they sought, and that we could never have enforced such a ban against the Soviets. Treaties, like other agreements, are enforceable only to the extent they create mutual rights and duties. In effect, because the Soviets succeeded in avoiding a broad binding commitment regarding the development and testing of mobile systems and components based on future technology, we cannot properly be said to be bound by such a commitment.

I wish to close by reiterating a critical point. Notwithstanding our belief in the merits of the broader interpretation, the President has decided to pursue the SDI program as currently structured, which can be accommodated within the confines of the "restrictive" interpretation—namely, research into, but not development or testing of, systems or components based on future technology and capable of substituting for ABM interceptors, launchers, or radars.

Senator WARNER. I want to include in the record the speech given by Secretary Shultz to which you referred earlier, Judge, so that we have the actual wording that he used.

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No. 246

REMARKS AND QUESTION AND ANSWER SESSION BY
THE HONORABLE GEORGE P. SHULTZ
SECRETARY OF STATE
BEFORE
THE NORTH ATLANTIC ASSEMBLY
ST. FRANCIS HOTEL, SAN FRANCISCO, CALIFORNIA

MONDAY, OCTOBER 14, 1985

Mr. President, distinguished delegates. My talk this morning is about our relations with the Soviet Union, a central issue for the Western democracies. But before I start on that, I want to say something about terrorism, because terrorism is the war we're fighting right now.

Terrorists and the regimes that support them aim to shatter our ideals and our principles, undermine our democratic life, and pull down civilization itself. We've learned some lessons in the few days just past. The event isn't over, but still while it's fresh in our minds, let me tell you three points that stand out in my own mind.

First, it tells us something about terrorists -- that they're animals, cowardly animals. These are not guerrillas. These are not fighters for some liberation movement. They select the helpless to torture and murder. They lack the guts to do battle, just as they lack the guts to seek justice and peace by negotiation. That's the first lesson. (Applause) It tells us that we must take action. If free peoples do not move against the terrorists, no one will stop them. We must have the courage to act without violence, if possible, but recognizing that violence sometimes cannot be avoided. If our dedication to that principle paralyzes us, all our principles will be in jeopardy. That's a little more sobering lesson, so I notice you didn't clap. But it's an important lesson. We have to be ready to act.

And, third, it tells us that the democracies must stand together in our own cause. Our nations are the founders and the defenders of the rule of law. The terrorists know and seek to turn that against us. They insist that we be rigorous in granting due process to the enemies of the rule of law, and, as they do, they seek to instill fear -- the fear that anyone who captures and brings to justice a terrorist becomes a target of terrorism.

We must stand for the rule of law, but we must not let fear turn it into a key to the jailhouse door. If we of the democracies stand together against this scourge, we will defeat it, and our ideals and values will thrive and be safe. I think we are now starting to do that.

I have a lengthy statement here that deals principally with the arms control matters being discussed in Geneva right now. I know it is too long, but it is an effort to pull together in one place where we are, they are, so we can see just what the issues are. So I ask you to bear with me and take it as a compliment, as you run out of patience, that we have thought, the President has thought, that this audience was the appropriate one to lay out in a rather painstaking way just what this is all about as we see it.

For 40 years, the Western democracies have wrestled with the problem of relations with the Soviet Union.

As legislators you know first hand that democracies love peace, and really do not like spending money on defense. But you also know how precious freedom and democracy are, and therefore how important it is that we defend the values that we hold dear. We democracies know that freedom has enemies in this world. But we also know that the purpose of our defensive strength is peace. Therefore we all conduct foreign policies whose aim is a more positive and constructive relationship between East and West.

Nearly two years ago, President Reagan offered the Soviet Union a challenge to begin building a more constructive relationship: He said, "Our challenge is peaceful. It will bring out the best in us. It also calls for the best from the Soviet Union ... If the Soviet Government wants peace, then there will be peace."

Since that time, we have made a start. The Geneva and other arms control negotiations are underway. We have initiated a process for discussing ways to defuse regional tensions and manage our competition peacefully. We have urged the Soviet Union to take practical steps to fulfill its international commitments on human rights. We have advanced ideas for expanding contact and interchange between our two societies, to fashion the network of bilateral ties that is a necessary feature of any productive relationship between two countries. These are steps forward, but much more needs to be done. One of President Reagan's major goals when he meets next month with General Secretary Gorbachev is to discuss this entire agenda giving new impetus to all of these efforts.

Arms control, of course, is a key part of this agenda. It has been a focal point of our Alliance deliberations for many years. Allied unity and support are a key to the success of our endeavors with the Soviet Union. And indeed, Europe's security is one of the principal objectives at stake.

In Geneva today, American and Soviet negotiators are in the middle of a new round of talks. An American proposal for radical reductions in offensive nuclear arms has been on the table for some time. The Soviet Union has recently come forward with -- and extensively publicized -- a new counter-proposal.

Let me review for you today where we stand, the United States and the Soviet Union, on the main issues in arms control.

OUR OBJECTIVES IN ARMS CONTROL

Let us start at the beginning. What is it we are trying to accomplish?

The purpose of arms control negotiations is not agreement for its own sake. A bad agreement could do harm. Loopholes could be a source of new mistrust; the structure of limitations could leave one side with special advantages that only leave the other less secure; loose limits could only legitimize an intensifying arms race in areas left open by the agreement. Saving money on weapons expenditure is, of course, a worthwhile goal, but it is not sufficient, or even the main issue.

What we really want, in short, are measures that enhance security and reduce the risk of war. Arms control is not just a technical exercise; it has to be embedded in a policy and in an environment that reduce our real dangers and make the world safer. The rivalry between East and West is not the result of personalities or simple misunderstandings. It is grounded in fundamental moral differences about justice and freedom; it is reflected in political differences over a range of international problems. Weapons are the symptom of this struggle, not its cause. Arms reduction can help reduce tensions; yet expansionist Soviet behavior can so fuel insecurity and mistrust that, at the very least, the arms control process is undermined. Do not forget that it was Soviet geopolitical challenges -- like intervention in Angola, Ethiopia, and most particularly Afghanistan -- that derailed detente and the Salt II Treaty in the 1970s.

Preventing a war means addressing not only these political conflicts but also the military postures of the two sides. In the nuclear age, even more than in the past, force structure can shape not only how a conflict might be fought, but more importantly, whether or not a conflict would break out at all. President Reagan's program to rebuild our military strength is addressed to this problem.

The concept of strategic stability is a fundamental one. At various periods in history, war was prevented by a balance of power. The balance was not always stable, but much of the time it worked, deterring attack by denying the attacker his confidence in victory and posing the risk of counter-attack. In the age of the ICBM -- the intercontinental ballistic missile with thermonuclear warheads -- security has had to rest largely on the threat of retaliation, since there has been no defense against these missiles. This form of deterrence -- the mutual threat of mass destruction -- is what Churchill called the "balance of terror."

Is this balance stable? Will it remain stable in the face of the steady Soviet build-up of weaponry with first-strike potential? Or is the balance in danger of breaking down in crisis conditions? This is one of the central issues -- if not the central issue -- in arms control today. We cannot afford -- as we have been tempted in the past -- to assume that the balance is automatically stable. We have come to recognize that the vulnerability of a country's retaliatory forces, in a crisis, could put a premium on striking first, or pre-emptively, and thus magnify the dangers. Or it could call into question America's commitment to effectively support its Allies against Soviet conventional attack.

This is why one of the key tests by which we judge arms control proposals is whether they will enhance strategic stability. The military balance that results from an agreement should be one that reduces the incentive for a first strike. It should enhance deterrence by ensuring that no first strike can succeed, that no one can be tempted by illusions of "victory". A stable environment reduces the incentive to build new weapons, and enhances the incentive to reduce the level of arms. It defuses the tension and danger of any crisis that may occur. Thus an emphasis on strategic stability goes to the heart of reducing the danger of the outbreak of war.

We must also remember that the forces of history have cast the United States in the role of the most powerful member of an alliance of democracies. Any agreement we reach with the Soviet Union must enhance our Allies' security as well as our own. Since 1945, Soviet military power has cast its shadow over both Europe and Asia; this is a reality, as is the relentless build-up of Warsaw Pact forces, both nuclear and conventional. The Western concept of security, which has kept the peace in Europe for 40 years, is that of a close and permanent link between Western Europe and the United States. The American pledge to underwrite the defense of Europe is given concrete expression in the presence of American forces and American weapons in Europe, which make it a certainty that any Soviet attack on Europe engages us. Thus our strategic forces defend Europe as much as they defend the United States. This is what deters war, and it has worked. Arms control must enhance, not weaken, this dimension of deterrence.

We have other criteria for judging arms control proposals:

-- An arms control agreement, to strengthen stability, should be based on equality, leaving both sides with equal or essentially equivalent levels of forces.

-- An agreement should emphasize strategically significant reductions. Past agreements only codified existing levels or rechannelled the competition. It is time, now, to reverse the pattern of constant build-up; it is time to begin radical reductions. (Applause)

-- An arms control agreement must be verifiable. The Soviets' selective record of compliance with previous agreements unfortunately makes this indispensable. Radical reductions, in fact, can increase the incentive to cheat, since a balance at lower levels can more easily be tipped.

THE US PROPOSAL

The United States has serious proposals now on the table at Geneva. We have been criticized for our restraint in the public relations field. But our proposals were not made for propaganda, they were made to make progress toward these central objectives. Our proposals cover reductions in strategic offensive forces; reduction or elimination of US and Soviet intermediate-range nuclear forces; and a serious dialogue on defensive weapons and the relationship between offense and defense. These issues are being discussed now in the Geneva negotiations in three separate but interrelated forums.

First, in the talks on strategic arms reduction, the United States has proposed radical reductions down to 5,000 ballistic-missile warheads on each side. This represents a cut of nearly 50 per cent from the current Soviet level. We have proposed substantial reductions in the number and destructive power of ballistic missiles, and limits on heavy bombers, on the cruise missiles they carry.

The strategic forces of the United States and the Soviet Union are very different. The great majority of Soviet warheads and destructive power are concentrated on their large, land-based ICBMs. We have a more balanced approach, with as much emphasis on submarine-based missiles and bombers as on ICBMs. The Soviet force is designed for pre-emption, ours for retaliation. These differences greatly complicate the achievement of an equitable agreement. We are prepared to explore trade-offs between areas of relative advantage -- such as our advantage in bombers versus their advantage in ICBMs -- to establish an overall balance.

Our proposal is comprehensive, but its core is a recognition that reductions should focus on the most destabilizing systems. Weapons like large fixed land-based ICBMs with multiple warheads, capable of destroying missile silos -- these are the most powerful strategic weapons, the most rapid, the most provocative, the most capable of carrying out a pre-emptive strike, the most likely to tempt a hair-trigger response in a crisis.

The Soviets have over 300 heavy ICBMs; we at present have none. Our first deployments of MX, a smaller missile but roughly comparable because of its accuracy, will begin late next year. With their accuracy, destructive power, and multiple warheads, the Soviet weapons are capable of destroying virtually the entire land-based portion of our retaliatory force. For nearly a decade this category of weapons has been, for us, one of the central issues of arms control. One of the odd features of the current debate is that the Soviets would have us believe that this central issue has disappeared. It is as if the threat from these powerful weapons, which already exist in the hundreds, is somehow less important than research into new categories of systems which do not exist, will not exist for many years at best, and will not come into being at all unless research is successful in meeting stringent criteria we ourselves have set.

The second negotiation in Geneva is about intermediate-range nuclear forces, or INF. This negotiation is taking place because in 1977 the Soviet Union began deploying SS-20 intermediate-range nuclear missiles in the western USSR, aimed at our European Allies, and in the Soviet Far East, aimed at our friends and Allies in East Asia. Today there are 441 operational launchers deployed; with three warheads on a missile, that makes over 1,300 modern nuclear warheads aimed at the cities and defense facilities of our friends and Allies.

In response -- and I repeat, in response -- the Atlantic Alliance decided in 1979 that it had no choice but to deploy weapons of its own in this category, as a deterrent, while seeking to negotiate with the Soviet Union on a formula for mutual restraint. The Soviets agreed to talk, but have not negotiated on the basis of mutuality. They insisted on their right to a monopoly of longer-range INF missiles; they waged an unprecedented campaign of political warfare to intimidate our Allies into retreating from the NATO decision of 1979. Our Allies -- governments and legislatures -- stood firm; NATO Pershing II ballistic missiles and ground-launched cruise missiles began to be deployed in several allied countries in 1983 -- six years after the SS-20 deployment began.

The United States proposed at Geneva that we agree to eliminate both sides' longer-range land-based INF missiles on a global basis -- eliminate. The Soviets refused. Then we proposed that both sides reduce to the lowest possible equal number of warheads. The Soviets still refuse. Our position is based on the principle of equality between the United States and the Soviet Union. And limits must be applied globally, since the SS-20 is a mobile missile, and it is not our objective simply to shift the SS-20 threat from Europe to Asia.

The threat of the SS-20 goes to the heart of our commitment to our Allies. These are weapons aimed at Europe -- although they could be aimed at America. Their purpose is to "decouple," that is to separate you from us by intimidating you. The Alliance's response is a united response, and a unifying response, in that it symbolizes once again that our destinies are tied together. The principle of collective security is thus confirmed and reinforced. Europe is safer, because deterrence is strengthened.

The third area of negotiation is that of defense and space arms. But the core issue is the same: the stability of deterrence.

The Salt I Accords of 1972 limited anti-ballistic missile systems and were also a partial first step toward limiting offensive weapons. We continue to comply with them, provided the Soviet Union corrects its non-compliance and negotiates seriously in Geneva. We must remember, however, that those Accords of 13 years ago, and the hopes they engendered, were founded on certain assumptions. Developments since then have called those assumptions into question.

First of all, when the ABM Treaty was signed, it was assumed that offensive weaponry would be reduced by further negotiations. In fact, offensive weapons proliferated. Each side now -- and particularly the Soviet side -- has vastly higher numbers than in 1972 -- vastly higher. We see the Soviet heavy ICBMs with a first-strike potential. On both sides we see offensive weapons of astonishing accuracy, and with multiple warheads. The Soviets are developing ~~two~~ new varieties of ICBMs whose mobility makes them harder to identify and count. If we fail to respond to these trends, at some point in the future they could undermine the military balance on which deterrence is based.

Second, in the ABM Treaty we also assumed that we had set up critical barriers that would prevent any breakout, that is, any sudden and significant expansion of ABM systems in violation of the Treaty. In fact, while the United States has dismantled even the one ABM complex that was permitted, the Soviets have taken full advantage of the deployments allowed by the Treaty. And some Soviet activities are clear violations, such as the large radar at Krasnoyarsk, which raises a question of whether the Soviets might be planning a nation-wide ABM system, negating the Treaty entirely.

But technological advance, which helps create these new problems, also offers other possibilities. Methods of defense against ballistic missiles, which were relatively rudimentary in 1972, now offer new hope as a possible counter to the growing offensive threat. What if it were possible, even in this age of ballistic missiles, to block an attack, rather than simply suffer the attack and then retaliate? What if the balance of power could rest more on a mutual sense of security, and less on a mutual threat of annihilation? Thus the President's Strategic Defense Initiative, or SDI, a research program to explore promising new technologies. Effective strategic defenses, able to intercept and destroy missiles before they reach their targets, would strengthen security. Even if far less than 100 per cent perfect, such a defensive system would vastly complicate any aggressor's first-strike planning and frustrate any temptation to consider launching an attack.

In an age of anxieties about nuclear weapons, this should provide enormous hope for the future. As former Soviet Premier Kosygin once eloquently stated, an anti-ballistic missile system "is intended not for killing people but for saving human lives".

The last few decades' emphasis on offensive strategies reflected the state of technology, not a law of nature. Mutual vulnerability was a fact of life, not a positive virtue. A new strategic equilibrium based on defensive technologies and sharply reduced offensive deployments on both sides could be the most stable and secure arrangement of all. It cannot be fully achieved without negotiations, and therefore we have sought the fullest dialogue on this subject with the Soviet Union -- as well as with our Allies. In fact, General Abrahamson, Director of our SDI Office, travelled to Geneva to take part in a briefing of the Soviet negotiators on our program, its potential and its prospects.

Our research program is and will continue to be consistent with the ABM Treaty. The Treaty can be variously interpreted as to what kinds of development and testing are permitted, particularly with respect to future systems and components based on new physical principles. The Treaty's text, the agreed statements accompanying it, the negotiating record, and official statements made since that time are subject to differing interpretations.

Because of the great potential contribution that SDI could make to our security, and because of our interest in a rigorous implementation of the ABM Treaty by both sides, we have devoted much attention to the question of how to interpret the Treaty. It is our view, based on a careful analysis of the Treaty text and the negotiating record, that a broader interpretation of our authority is fully justified. This is, however, a moot point; our SDI research program has been structured and, as the President has reaffirmed last Friday, will continue to be conducted in accordance with a restrictive interpretation of the Treaty's obligations. (Applause) Furthermore, any SDI deployment would be the subject of consultations with our Allies, and to discussion and negotiation, as appropriate, with the Soviets in accordance with the terms of the ABM Treaty.

Our policy thus reflects:

-- The President's commitment to explore thoroughly the potential contribution of strategic defenses to peace and stability, and his vision of a "balance of safety" replacing the "balance of terror."

-- Our commitment to pursue the program as currently structured, which is consistent with a restrictive interpretation of our obligations under the ABM Treaty.

-- Our judgment that the SDI Program, provided that it is consistently funded at the levels required, will be adequate to answer the question of whether a cost-effective and survivable defense against ballistic missiles is feasible.

In sharp contrast to Soviet behavior, our policy of restraint with respect to the conduct of the SDI Program demonstrates by deeds US seriousness and sincerity in seeking a more stable international environment

The American proposals in Geneva are a comprehensive blueprint for reducing nuclear weapons, for strengthening deterrence, and for making the world safer. They are paralleled by other proposals in other forums:

-- To strengthen safeguards and controls against the proliferation of nuclear weapons capabilities.

-- To ban chemical weapons, and to prevent chemical weapons proliferation.

-- To stabilize the conventional military balance in Europe, by mutual and balanced reductions of forces, and by measures to reduce the risk of war by surprise attack, accident or miscalculation, which would give concrete form to a reaffirmation of the principle of non-use of force.

This is President Reagan's arms control agenda -- the most comprehensive arms control agenda of any President in our history.

THE SOVIET COUNTERPROPOSAL

Now we have, at long last, a Soviet counterproposal in Geneva. It could be a step forward, and thus, in and of itself, represents a success for our Alliance policies. The very fact that the Soviets have offered a new proposal is directly due to the patience, strength, and unity of the Western democracies. (Applause) We have maintained our principles and our standards, and these in turn are carrying us farther than skeptics had believed possible.

Remember that for over a year in 1983 and 1984, the Soviets boycotted any negotiation of these issues. That effort to intimidate the Alliance failed, just as their earlier efforts to block INF deployments failed. Continued Alliance firmness and unity eventually brought the Soviets back to the negotiating table earlier this year. In these new talks, the Soviets stated in the most general terms that they agreed with us on the importance of offensive reductions. But they gave no specifics. Rather, they have devoted their greatest effort to propaganda against SDI and held everything hostage to getting their way on SDI.

Two weeks ago, the Soviets did begin to offer specific and detailed ideas about deep cuts in offensive forces. We welcome this. While some of their ideas may indicate progress, altogether the new Soviet position, however, remains deeply flawed and self-serving. It would have a particularly dangerous impact on the security of our Allies. Let me touch on the highlights.

The Soviet proposal is a combination of various bans, freezes, limitations, and reductions of some but not all offensive forces. Overall the Soviets propose a reduction by 50 per cent of each side's "delivery vehicles which can reach the territory of the other side". It's their definition.

The hooker is their definition of what they consider "relevant" systems -- systems which can strike the territory of the other side. Under their definition American systems in Europe pointed toward the USSR are constrained, while Soviet missiles and aircraft aimed at Europe are not. It would imply no necessary reduction of the SS-20 threat (which, incidentally, can reach Alaska) but calls for a unilateral withdrawal of the United States counter to that threat. I can think of nothing that would more smack of a United States-Soviet deal at Europe's expense, and we won't do that. (Applause)

This one-sided definition is a step backward. It is the Soviet position of 1969, which the United States and its Allies could not accept then or at any time since. It is not reflected in the SALT I Accords nor in SALT II nor in the distinction between Strategic and INF Systems that was the basis of the Geneva negotiations from 1981 to 1983.

The Soviets also propose to limit what they call "nuclear charges" -- that is, warheads and bombs -- on strategic forces to 6,000. Of these 6,000 weapons no more than 60 per cent could be on any one component -- that is, ICBMs, submarine-launched ballistic missiles, or aircraft. This would limit the number of Soviet ICBM warheads to 3,600 -- but there is no commitment to reduce their most destabilizing heavy ICBMs, the SS-18s. Thus the Soviet proposal does not directly address the main problem of strategic stability. With deep reductions in US systems, it would add to NATO's vulnerability and increase the significance of the Soviet advantage in hard-target-killer ICBMs.

The Soviets also propose to ban or severely limit all "new" nuclear delivery systems, defining as "new" those systems not tested as of an agreed date. Assuming the agreed date would not be in the past, such a ban would preclude our Midgetman missile -- which was recommended, as you remember, by the Scowcroft Commission, and which would add to stability -- D-5 Trident submarine missile, and Stealth bomber. Oddly enough, it would allow the two new ICBMs (the SS-X-24 and the SS-25), new submarine-launched ballistic missile, and new Blackjack bomber they are now testing or deploying. It's a hell of a deal. (Laughter)

The Soviet position on INF is not totally clear. But to the extent that they now agree that an acceptable INF Accord could be concluded separately -- no longer held hostage to SDI and other issues -- we would regard it as constructive. And implicit in their new position may be a grudging acceptance of the presence of some US INF missiles in Europe defending our Allies.

However, they propose a stop to all further deployments in Europe of intermediate--range nuclear forces. This would halt NATO's INF deployment at about 200 warheads -- while they have about seven times as many SS-20 warheads already deployed. And it would permit unlimited new SS-20 deployments against our Allies and friends in Asia.

The Soviets also ask to be "compensated" in these negotiations for the British and French strategic nuclear deterrents. This is not only part of their effort to undercut NATO's decision of 1979; it is also an effort to undercut support for British and French nuclear forces. Yet those forces represent those countries' determination to maintain their independence and their control over their own destiny in the face of the nuclear danger. Those independent forces contribute to deterrence and to Europe's security. Of course, in the context of deep US and Soviet reductions, British and French forces could become a relatively larger part of the picture. And both countries have made clear that in that context they would consider discussions of their forces.

The Soviet proposal tabled in Geneva, finally, indicates that all limitations on offensive forces are contingent on banning SDI -- banning not only its testing and deployment but also "scientific research." This is rather sweeping. Indeed it flies in the face of the ABM Treaty, which puts no limits on research.

The problem is that, just as with SS-20s, the Soviets have not yet given up their efforts to keep a unilateral advantage. They want to stop our program while they continue their own program in the same field. Behind the curtain that encloses Soviet society, free from the scrutiny or open debate we have in the West, a major Soviet strategic defense program has proceeded for decades. In the past 20 years, the Soviets have spent about as much on strategic defense -- missile defense, civil defense, and air defense -- as they have spent on strategic offense. They deploy the world's only operational ABM System, and are continuing to modernize it. Their propaganda about the so-called "militarization of space" rings rather hollow when one considers that they have the world's most active military space program; last year they conducted about 100 space launches and nearly 80 per cent of them were military in nature, while the United States had only about 20 total space launches. The

Soviets also have the world's only extensively tested and fully operational anti-satellite system. And their own research efforts into SDI technologies -- high-energy lasers, particle-beam weapons, radio-frequency weapons, and kinetic-energy weapons -- long antedate our own. Indeed, some of the Soviet scientists most active in signing declarations against our SDI Program are themselves the men leading the Soviet military research in the same technologies.

I said it at the United Nations and I will say it again: the Soviet leaders know full well their own programs in these fields. Their propaganda against American programs is blatantly one-sided and not to be taken seriously.

Aside from the central issues of the Geneva nuclear and space talks, the Soviets have taken constructive positions in some fields and less constructive positions in others.

In the struggle against nuclear proliferation, for example, they and we have worked together well. We welcome Mr. Gorbachev's expression of interest in working with us to check the spread of chemical weapons.

Their proposed moratorium on nuclear testing, however, was aimed more at invidiously publicizing the Hiroshima Anniversary than at serious arms control. Let us remember that in 1962, after the Soviets had unilaterally broken an earlier joint moratorium on nuclear tests, President Kennedy said, "We know now enough about broken negotiations, secret preparations, and the advantages gained from a long test series never to offer again an uninspected moratorium". We have stressed over and over again the crucial importance of improving verification, whether with respect to the threshold test ban or any other more ambitious effort. We have on the table some precise and practical ways to move forward on verification. For example, we have proposed that they send experts to our nuclear test site to measure the yield of a nuclear test in order to provide better calibration of their instruments and thus more accurate verification.

The Soviets are also practitioners of vague, superficially attractive proposals like non-use of force, no-first-use of nuclear weapons, or nuclear-free zones. The problem with such ideas is that they are a kind of escapism, evading the reality of the political problems that give rise to conflict. Peace will ultimately depend on solving the political problems, not on high-sounding declarations. We recall the basic principles of US-Soviet relations of 1972, and the 1973 Agreement on the prevention of nuclear war. These Accords stated the right principles -- particularly the need to forswear the perpetual quest for unilateral advantage. The problem was not the principles but the performance. Soviet calls for the non-use or threat of force look rather unimpressive against the background of events in Afghanistan or Poland.

PROSPECTS

In sum, the new Soviet positions on arms control could be a step forward, but do not meet the basic criteria of strengthened stability, equality, strategically significant reductions, and increased verifiability. But we approach this positively. We are now in a new phase of the negotiations in which, if the Soviets are serious, real progress can be made. The President has given our negotiators unprecedented authority to explore ways of bridging differences. Whether or not there is genuine progress before the time of the President's meeting with Mr. Gorbachev, we at least are now both getting down to business.

You hear from the Soviets a lot of talk about the "increasing danger of war". This is propaganda designed to intimidate. Deterrence has kept the peace, certainly in the NATO area. With the restoration of Western strength in the last few years, the world is really more stable and secure than it has been in a long time. It is when the West is weak that the world is a more dangerous place.

So we will pursue arms reductions, with seriousness and dedication, but also with realism.

We have a complex task. As the President has put it, "We must both defend freedom and preserve the peace. We must stand true to our principles and our friends while preventing a holocaust".

There is no escape from this dual responsibility. The world we seek is a world of both peace and freedom. Such a world is attainable if the democracies are true to themselves and steadfast of purpose.

Thank you.

(Sustained, standing applause)

SECRETARY SHULTZ: Thank you very much. You're very generous in your response. I appreciate it.

SIR PATRICK WALL: Mr. Secretary, I would like to thank you on behalf of all the delegates for the very important statement you have made to us today. Now we would like to take advantage of your offer to answer questions for fifteen minutes. Before calling the first speaker, may I make two points: In view of the shortage of the time, I will only accept questions and not statements; and, secondly, in view of these arc lights, it is practically impossible to distinguish people's faces. So for those who want to speak, if they will wave their arms very vigorously, we'll do our best to identify them. Thank you. Now, who is the first speaker -- questioner?

THE NETHERLANDS (Ton Frinking): Mr. President, I would like to ask the question, in what way is the U.S. ready to negotiate SDI in Geneva?

SECRETARY SHULTZ: We are prepared to discuss the question of offense/defense relationships. We have stated that our program is a research program. We have been prepared and have described it carefully. We intend to conduct our program within a rather restrictive definition of what the ABM Treaty calls for, and we are prepared to talk about how there might be a shift from the present offense-dominated system of deterrence to one in which there is, in our view, a more stable arrangement with a mixture of offense and defense.

SIR PATRICK: Dr. Duffy, from the United Kingdom.

UNITED KINGDOM (Dr. Patrick Duffy): Mr. President, Mr. Secretary Shultz described the difficulties in the way of achieving agreement on deep cuts in nuclear weapons, given the asymmetrical differences in weapons systems, and therefore on the underlying strategies and overall policies. And does this not suggest that in order to get that agreement on deep cuts, a certain risk-taking on the net effects must be accepted by one side or the other? And, given his claim and his closing words, that thanks to deterrence the world now is more stable and secure, how far is the West prepared to seek agreement, even in the event of a little risk-taking?

SECRETARY SHULTZ: Well, I think it's a rash person who would risk freedom unnecessarily. There is no need to do that. We have a balance and we believe that a proper deterrence should see the balance go down in a way that enhances strategic stability and preserves and points toward equality. Those are the ingredients that we seek.

Now, you're perfectly right, and I think touch on a central problem, in pointing up the fact, as I tried to do in my talk, that our force structure and their force structure differ quite importantly with their much greater emphasis on the land-based ICBM's and our more equally distributed forces in the Triad of our forces. So that means, of course, that neither side, though you might try, can call for the other to restructure its forces in your own image. That would be unrealistic to do. And that is the reason why, as we have approached these strategic -- the START talks, we have said we are prepared to talk about trade-offs, because, obviously, as you go down with force structures that are very different, you have to have a way of trading off, in a sense, one kind of system against another. So we're prepared to do that.

Now, however, a key point that we cannot lose sight of is that the most destabilizing, the most dangerous, the most prone to use for a first-strike weapon are the heavy, accurate ICBM's, which the Soviet Union now has all there are, although we have some coming on stream. So if we're going to reduce in a manner that enhances strategic stability, we have to get some reductions in those forces. And that's why -- among the reasons why, when you consider some number or some percentage, it's a question, "Percentage of what?" is key, and we think there ought to be some percentage of these heavy destabilizing weapons in the mix.

SIR PATRICK: One of the Italian delegation is trying to catch my eye. I can't distinguish who it is from here. Will you put your hand up, if the person from the Italian delegation wants to speak? Yes. Right. You, sir.

ITALY: I am Aristede Gunnella from the Italian delegation. I would like to express my thanks to Secretary Shultz for his extremely interesting address, and I would like to ask a question: To what extent and in what way is the United States in a position to engage the NATO allies, not only from the industrial standpoint, but also from the standpoint of scientific research, and, above all, political research within the context of SDI? Thank you, Mr. Secretary.

SECRETARY SHULTZ: The United States has sought to describe to our allies, not only in Europe but elsewhere, as in Japan, the nature of the SDI research program and to invite them to take part in it; and that process of discussion, and to a certain extent negotiation about the conditions under which that partnership would go forward have been moving along. And some nations take the view that they don't want to take at least a governmental part in it. Others, I think, are desirous of doing so. Some say, "Well, it's up to industrial companies or research laboratories to decide for themselves."

So we are quite prepared to work with others in the development of this program, and we believe that in doing so we benefit the program, because it's demonstrable over the history of the development of modern science how much contribution has come from all the different countries in the Alliance. So it will be a better program, and also the results will be better understood. And, as there may be some fallout from this, say over into the area of conventional weaponry or over into the area of civilian commercial uses, people will have a sense of what's going on. So we think those are all positive attributes of the program, and we're quite prepared to work with others and have them have a piece of the action.

SIR PATRICK: Next questioner is Mr. Daillet from France.

FRANCE (Mr. Jean-Marie Daillet): Mr. Secretary, in the very important statement that you have just made, one particular point intrigued the French delegation, indeed. In your remarks you referred to a statement and an indication whereby in the event of an agreement on strategic disarmament, the governments of France and Germany would consider in turn sharing or participating in negotiations involving your own strategic forces, and we are wondering about this affirmation that you have just made. We don't really see what you are referring to, Mr. Secretary. Thank you.

SECRETARY SHULTZ: Well, I'm referring to the clear fact that if we are able to get radical reductions, so we are really moving toward what the President has set out as our goal, namely, the complete elimination of nuclear weapons, that when you get down to a point below -- considerably below where we are, then it can no longer be argued that the British and the French -- not the French and German, but the British and the French systems, are an inconsequential number in comparison with the total. I might say, the Chinese need to be included in this equation as well. So that if we get down to those places, then from the standpoint of really eliminating nuclear weapons, you have to include all the states that have nuclear weapons, and they have to come into agreement.

Now, it is my understanding that President Mitterrand, Prime Minister Thatcher, and also Deng Xiaoping have all said that when the time comes, if it does, that they are ready to participate. So that's what I was referring to.

Now, I might say, beyond this kind of participation, the goal of elimination of nuclear weapons casts special importance on the non-proliferation regime, and on maintaining it and working for it, because, obviously, if we want to eliminate nuclear weapons from those who openly have them, we don't want other states to acquire them. And that is why we have worked so hard on the non-proliferation regime, and why I called attention in my talk to the sense in which we and the Soviets have been able to work effectively together on this subject. And I think it may have escaped your notice, but it's a matter of considerable importance.

SIR PATRICK: We are growing out of time, and I propose to call three more questioners: Mr. Hysing-Dahl from Norway; Mr. Guenther from the Federal Republic of Germany; and one from the delegation of Turkey.

NORWAY (Mr. Hysing-Dahl): Mr. President, Mr. Secretary. Mr. Secretary, thank you for your very valuable statement. My question: In this period we are now passing through with the Soviet very intense propaganda, good-will campaign, are the intermediate-range Soviet missiles, SS-20 among others, still being continually manufactured and deployed, or are they living up to what they have been saying for a couple of years, that this would stop?

SECRETARY SHULTZ: The numbers deployed, in our estimation -- we think we keep pretty close touch -- now are very considerably in excess of those when The Netherlands decision was made. In other words, they have continued to deploy. They have been rearranging their forces somewhat, and they have been making way for the new SS-25s that they are deploying, but the numbers have continued to increase.

SIR PATRICK: I'm sorry. I got the name wrong. I now call Mr. Pawelczyck from the Federal Republic of Germany.

FEDERAL REPUBLIC OF GERMANY (Mr. Pawelczyck): Secretary Shultz, at the conference on the interpretation of the ABM Treaty, there were some uncertanties. The delegation of the Federal Republic of Germany had a briefing session before they came to San Francisco, and we were given the following interpretation about research. And I should like to ask you whether your brief comments should be construed to imply the same meaning, namely, that between research, on the one hand, and the development and deployment of the rocket defense systems on the other hand, a strict line of differentiation has been drawn? And that is before one goes beyond the level of research, the partners in the Alliance will be consulted and an attempt will be made to come to terms, cooperative terms, with the Soviet Union. Is that true?

SECRETARY SHULTZ: As I understand the question, it was whether or not if the research pans out and before any deployment, there will be thorough discussion with the allies and negotiations with the Soviet Union.

The answer to that is yes, but I don't think that is the key question that's being debated. The question is, really, in the conduct of research designed to answer the question, is it possible to defend yourself against ballistic missiles -- how much development and testing, to what degree of a system and components, and so forth, are you talking about? And, if you were to go according to agreed statement D in the ABM Treaty, you would think that if you were talking about systems based on so-called "new principles," that creating such a system, which means research and testing and development, could go forward relatively unimpeded by these restrictions.

But the President has chosen to take a narrower interpretation in the pursuit of our SDI research program, which restricts to a greater degree the nature of the testing that can be undertaken, although, obviously, you can't just think about things in your mind; you have to test out principles.

SIR PATRICK: Last question. The gentleman from Turkey.

TURKEY (Farruh Ilter): I shall be very brief, Mr. Secretary. I am unable to explain my thinking in English, and that is why I would like to give you the benefit of my thinking in French.

First of all, it is generally accepted that the threat -- that terrorism is a threat to democracy, to the strength of democracy, and it also is a threat to human values. That has to be said. But I don't think it is enough. I don't think that will go far enough to do away with terrorism.

What do you think we ought to do to do away with terrorism? Please tell us about your thinking. How can we eliminate terrorism. (Laughter from audience)

SECRETARY SHULTZ: Everybody settle down here. It's going to take a while. (Laughter)

I'm very glad that you brought this conference to that subject, because it is something that is already taking place on too wide a scale, and we must deal with it and beat it back and eliminate it. Now, how do we do that?

First of all, I think we have to, as peoples in a democracy, all recognize this virus for what it is and determine to work together to stamp it out. So that means, of course, doing certain defensive things. That means improving our intelligence in every way that we can so that we know what is going on, not only country by country, but since we are dealing with an international phenomenon, we have to develop a capacity to share intelligence among each other and work together as something happens.

I might say that it is not known very much, but is a fact, that we are having more success with this than is commonly realized, since in the last 12 months not just the United States but working together with the governments in this room and some others, we have managed to find out about ahead of time and prevent, expose, in some way defuse, planned terrorist incidents. So we are getting somewhere with the intelligence. But we have got to keep the pressure on this and we have to be prepared to use all kinds of intelligence: SIGINT, photography, human intelligence, and so forth. They all need to be developed well. We need to share our ideas on how to defend ourselves, how to construct our buildings and conduct ourselves, particularly in the diplomatic community which is such a target, in a way that deters and to be careful about our airports. Let's not let our guard down.

There have been a huge number of weapons or explosive devices -- I think, something on the order of 35,000 in the last ten years discovered of people trying to get on airplanes in the United States through these devices that we have. So those work. And we have to use them and not let down our guard, not get careless.

When we get our hands on terrorists, we have to prosecute them. We shouldn't hesitate about that.

(Applause)

And we have to be willing to take action, action in accordance with our values. We don't want to turn ourselves into people that adopt the terrorist values in attacking them. That would be a triumph for them. We are law-abiding countries. However, we don't want to, as I said, allow our tendencies, our desire to be law-abiding, to stand by our principles, to be used by terrorists, and to allow them to use fear as a key to the jailhouse door. That is no thing for us to do.

So we have to be willing to take action and not be afraid to do so. It has to be a proper action, and I think that we saw an illustration a few days ago when President Reagan ordered our planes to bring that plane in to the Sigonella Airport. That was action. And we do have four terrorists in Italian jails, and the Italians, I am sure, will bring them to proper justice.

Those are the kinds of things that we have to do. They are collaborative things. We have to work together. And we have to avoid provocative matters, and I expected you to bring up from Turkey, and I won't even mention it here for fear of giving it some publicity, but there is no point in doing things that only inflame people and lead to terrorist acts on the part of various groupings that are unwarranted. So we can win this battle. We have to identify it clearly. We have to recognize the problem. I think that is happening. And then we have to use the tools available to us, and we do have tools available to us and use them firmly and use them in a determined way.

(Applause)

SIR PATRICK: That language brings the end of our question period. We are immensely grateful to you, Mr. Secretary, for your address and questions. We know you have to leave, and we wish you well..

(Sustained, standing applause)

Senator **Warner**. Did he specify the duration of the policy decision to follow this particular interpretation?

Judge **Sofaer**. The decision has been put in terms consistent with what the President has said from the initiation of the SDI Program. We are going to follow a program of research until we get to the point where we can see what the technology is capable of achieving.

At that point a decision will be made as to whether to proceed to testing, development, and ultimately deployment of SDI components and systems, whatever they might end up being called. The world "component" itself is really a word of art and it refers to those three components in article II.

Senator **Warner**. Was the administration's review of the ABM Treaty limitations on exotic technologies prompted by the Soviet proposal to ban so-called "base strike weapons" systems that we felt the ABM Treaty already restricted?

Judge **Sofaer**. Not so far as I know, Mr. Chairman. I do not know of any such specific reason.

Senator **Warner**. Since the issue of the ABM interpretation has arisen, it has been commonplace to characterize more restrictive interpretation as the "traditional" or "accepted" interpretation.

Does your review of the treaty and related documents support this characterization and did you trace the origins of the restrictive interpretation?

Judge **Sofaer**. Mr. Chairman, I am happy that you raised that question. Indeed, in your opening statement you referred to it as the traditional, or some such word, interpretation.

I do not accept that characterization of the restrictive view. My office has prepared a memorandum demonstrating that the so-called restrictive interpretation cannot be regarded as having been authoritatively accepted and adopted by the U.S. Government.

On the contrary, nearly all U.S. Government explanations of the treaty during the ratification period are consistent with the broader interpretation. This is significant since these statements, the ones in 1972 and 1973, were closer in time to the treaty's adoption.

The restrictive view became common only after the SDI program was announced. Opponents of SDI have advanced it to prevent expansion of SDI. Those who support research under SDI, but not testing and development, have used it to buttress their view of how SDI ought to come out.

I must say it may well be that some proponents of SDI have resorted to the restrictive interpretation to sell it to Congress more readily. I believe that all of these people have acted in good faith, but not with the proper in-depth examination of the treaty and the history of the treaty that was required.

The Soviets did not originally articulate the restrictive interpretation. Their initial criticisms of SDI accused it of many things, including violations of certain provisions of the ABM Treaty, but they did not initially charge that development and testing of SDI components would violate the treaty—only that deployment would.

Not until this year, and especially after the McFarlane statement on "Meet the Press" which has become so famous, did the Soviets unambiguously advance the restrictive interpretation as part of their campaign to block the SDI Program.

I have that memorandum, Mr. Chairman, and I will be happy to make it part of the record if you wish.

Senator WARNER. Without objection, it will become part of the record.

[The memorandum follows:]

[U.S. Department of State, Washington, DC, Oct. 30, 1985]

ANALYSIS OF U.S. POST-NEGOTIATION, PUBLIC STATEMENTS INTERPRETING THE ABM TREATY'S APPLICATION TO FUTURE SYSTEMS

SUMMARY

Proponents of a "restrictive" interpretation of the latitude granted by the ABM Treaty with respect to future systems have frequently asserted that this restrictive view is the "traditional" U.S. position. Ambassador Smith, for example, has described the restrictive view as the unvarying U.S. interpretation for the past 13 years.

A careful review of the record, however, demonstrates that the restrictive theory cannot accurately be labeled traditional. For example, in every one of its periodic compilation of arms control agreements, from 1975 to the most recent edition in 1982, ACDA offered the following description of the ABM Treaty: "Further, to decrease the pressures of technological change and its unsettling impact on the strategic balance, both sides agree to prohibit development, testing, or deployment of sea-based, air-based, or space-based ABM systems and their components, along with mobile land-based ABM systems. Should future technology bring forth new ABM systems 'based on other physical principles' than those employed in current systems, it was agreed that limiting such systems would be discussed, in accordance with the treaty's provisions for consultation and amendment."—(ACDA, Arms Control and Disarmament Agreements 138 (1982 ed.); see also the 1975, 1977, and 1980 editions.)

This ACDA statement is in accord with a majority of USG explanations or interpretations of the Treaty given at or near the time of its signature and ratification. The early statements are consistent with the "broader" reading of the Treaty: that systems based upon future technologies are dealt with exclusively in Agreed Statement D, which bans only their deployment.

Several later official statements support the restrictive interpretation. The overall record of post-negotiation statements, however, is mixed. Certainly, there has been no one uniform, unvarying interpretation of the Treaty.

When greater weight is accorded to earlier statements the record can fairly be read to support the so-called broader interpretation. Attaching greater weight to these earlier statements is justified by standard principles of interpretation. Those statements are more nearly contemporaneous with the drafting, signature, and ratification of the Treaty than are later statements. Moreover, they were made in the context of a detailed description of the Treaty's content to both the Congress and the public and are thus more accurate and reliable indicators of its meaning.

ANALYSIS

Three distinct time periods are considered: (A) between signature and ratification; (B) during the ratification process; and (C) post-ratification.

A. The period between signature and ratification

Of the USG statements made in the period between the ABM Treaty's signature and its ratification, we have found two that dealt with the Treaty's application to future systems.

On May 26, 1972, the day the Treaty was signed, Ambassador Smith and Dr. Kissinger (then National Security Advisor) held a news conference in Moscow to present the Treaty to the press. Kissinger undertook to provide "a general background of the [ ] negotiations," recognizing that Smith was "in the best position to go through the details of the agreement."—66 DOS Bulletin 868 (1972).) In the course of this article-by-article review of the Treaty, Smith offered the following analysis: "Now, article II defines what we are talking about and has a very important bearing on the whole question of what we call future ABM systems. This treaty has as a most significant aspect that it not only limits the present situation but has a choking-off effect on future systems which, under the terms of the treaty as we have reached understandings, will not be *deployable* unless this treaty is amended.—(66 DOS Bulletin 870 (1972) (emphasis added).)

It is unlikely that Ambassador Smith, the negotiator of the Treaty, would have referred to only a ban on deployment if he had meant testing and development were banned as well. Moreover, Smith failed to refer to Article V as relevant to the "choking-off" of future systems.

The second preratification statement was made in a report by Secretary Rogers to the President on June 10, 1972. The report was part of the Secretary's formal submission of the Treaty to the President for transmission to the Senate for its advice and consent to ratification. This report is the most comprehensive official USG explanation of the ABM Treaty. It has a subsection explicitly dealing with future systems. Subsection 3, "Future ABM Systems," of the part of the report entitled, "Limitations on ABM Systems," provides this analysis: "A potential problem dealt with by the Treaty is that which would be created if an ABM system were *developed* in the future which did not consist of interceptor missiles, launchers and radars. The Treaty would not permit the *deployment* of such a system or of components thereof capable of substituting for ABM interceptor missiles, launchers, or radars. . . ."—(67 DOS Bulletin 6 (1972) (emphasis added).)

This description of the limitations placed on future systems by the Treaty does not mention Article V. Instead, it quotes from Articles II and III and Agreed Statement D. This strongly indicates that Article V was not thought to apply to future systems; rather, those systems were regulated by Agreed Statement D. The report expressly contemplates the "development" of future systems; given the context, it is unlikely the term "developed" was casually used. Moreover, the section immediately preceding the "Future ABM Systems" section, entitled "Development, Testing, and Other Limitations," expressly dealt with Article V, but did not mention future systems.

B. The ratification process

1. Prepared statement to committees.—Extensive Congressional hearings were held on the two SALT I agreements. In the course of these hearings, the two principal administration spokesmen on the ABM Treaty, Secretary Rogers and Ambassador Smith, made prepared statements touching upon the treatment of future systems.

Rogers made two such statements. In his testimony to the Senate Committee on Foreign Relations on June 19, 1972, Rogers provided the following description of the Treaty's prohibitions.

"The treaty provides for the other important qualitative limitations. The parties will undertake not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based. They have also agreed not to develop, test, or deploy ABM launchers for launching more than one ABM interceptor missile at a time from each launcher, nor to modify launchers to provide them with such a capability; not to develop, test, or deploy automatic or semi-automatic or other similar systems for rapid reload of ABM launchers; not to develop, test, or deploy ABM missiles with more than one independently guided warhead.

"Perhaps of even greater importance as a qualitative limitation is that the parties have agreed that future exotic types of ABM systems, i.e., systems depending on such devices as lasers, may not be deployed, even in permitted areas."—(67 DOS Bulletin 52 (1972).) "Similarly, in his testimony before the House Foreign Affairs Committee on July 20, 1972, Rogers first listed prohibitions contained in other parts of the Treaty, including Article V. He then noted: "Such limitations are important. It may be of even greater importance that both sides have agreed that future types of ABM systems based on different physical principles, for example, systems depending on such devices as lasers, that do not consist of ABM interceptor missiles, launchers, and radars, cannot be deployed even in permitted areas. So there is a limitation on what may be employed in the ABM systems now in operation and it prohibits the deployment of new esoteric systems in these areas."—(1972 Documents on Disarmament 492).

Both of Rogers' statements contradict the "restrictive" interpretation. They treat the prohibition on future systems as distinct from the Treaty's other prohibitions, undercutting the assertion that Article V applies to future systems. In addition, far from treating Agreed Statement D as redundant, Rogers seems to attach great, independent importance to it.

Ambassador Smith's statements follow the same lines as his earlier comment at the Moscow news conference and are in accord with the views expressed by Secretary Rogers. On June 23, 1972, Smith told the Senate Committee on Armed Services that "[t]he development and testing, as well as deployment, of sea-, air-, space-based, and land-mobile devices is prohibited. Of perhaps even greater importance, the parties have agreed that no future types of ABM systems based on different physical principles from present technology can be deployed unless the treaty is amended." (67 DOS Bulletin 148 (1972)) Similarly, his statement to the House Armed Services Committee on July 25, 1972 first reviewed the restrictions of Article III and Article V, and then offered the following observation: "Of perhaps even greater importance as a qualitative limitation is the prohibition on the deployment of future types of ABM systems that are based on physical principles different from present technology." (1972 Documents on Disarmament 522.)

Smith explicitly located this ban on deployment in Agreed Statement D: "On this point, Mr. Chairman, there is an agreed interpretation with respect to ABM systems based on different physical principles, and including components capable of substituting for those components used at present—that is, launchers, missiles and radar components. If such new systems are developed, and one or the other side wants to deploy them under the limitations of this treaty, there would have to first be a discussion of the question in the Standing Consultative Commission we are proposing to establish under this treaty, and then the treaty would have to be amended before such novel ABM systems could be deployed."—(Id.)

In this analysis Smith makes clear that the Treaty's ban on future systems is found in Agreed Statement D and recognized that such systems could be developed. It is unlikely that the lead U.S. negotiator, in a prepared statement in this context, would have imprecisely used the term deployment—a term of art under the Treaty. The testimony does not support Smith's current statements that he viewed Agreed Statement D as limited to fixed land-based systems, or as superfluous—views central to the "restrictive" interpretation.

2. Oral testimony before Senate Armed Services Committee.—Another source of information from the ratification process is the responses of various witnesses to questions from Committee Members. The most extensive hearings on the pact were held by the Senate Committee on Armed Services. (See Military Implications of the Treaty on the Limitations of Anti-Ballistic Missile Systems and the Interim Agreement on Limitation of Strategic Offensive Arms: Hearings Before the Senate Committee on Armed Services, 92d Cong., 2d Sess. [hereinafter cited as "Hearings"]) During the course of these, and other, Congressional hearings, the issue of future systems was addressed. Several statements made by Administration witnesses dealt with the issue. While these statements may be crafted less carefully than prepared statements, they still provide some insight. The record as to such statements is more ambiguous than that of the prepared statements; certain statements could be read as supporting the "restrictive" view, some the "broad."

In response to a question in the Senate Foreign Relations Committee Hearings about the use of lasers as an ABM system, Secretary Rogers noted that "[u]nder the agreement we provide that exotic ABM systems may not be *deployed* and that would include, of course, ABM systems based on the laser principle."—(Strategic Arms Limitation Agreements: Hearings Before the Senate Committee on Foreign Relations, 92d Cong., 2d Sess. 20 (1972) (emphasis added).)

Rogers mentioned no limitation on development or testing. Similarly, Ambassador Smith made several comments in response to questions that reaffirmed his earlier statements. The following exchange is illustrative:

Senator SMITH. Mr. Ambassador, you say that the treaty prohibits the development of other ABM systems. Would this affect a development of a laser ABM system by the United States?

Mr. SMITH. Senator Smith one of the agreed understandings says that if ABM technology is created based on different physical principles, an ABM system or component based on them can only be deployed if the treaty is amended.

Work that is direction, development work, research, is not prohibited, but deployment of systems using those new principles . . . would not be permitted unless both parties agree by amending the treaty.—(Hearings at 295).

Smith later reiterated this point, responding "no" to the question: "[U]nder this agreement are we and the Soviets precluded from the development of the laser as an ABM?" (Hearings 306) Smith did not distinguish between fixed land-based lasers or space-based lasers. The import of his comments is that he viewed future systems such as lasers as regulated exclusively by Agreed Statement D.

Some witnesses made statements that support the "restrictive" view. For example, Dr. John Foster, Director of Defense Research and Engineering, appeared to read Agreed Statement D as limited to fixed land-based systems. Foster, in describing the impact of the Treaty on defense research, said "[o]ne cannot deploy a fixed land-based laser ABM system which is capable of substituting for an ABM radar, ABM launcher, or ABM interceptor missile. . . . You can develop and test up to the development phase of future ABM system components which are fixed and land based." (Hearings 275.)

Similarly, General Palmer, Acting Army Chief of Staff, stated at one point that "[w]e can look at futuristic systems as long as they are fixed and land based." (Hearings 443) This assertion, however, must be read in light of General Palmer's earlier testimony:

Senator GOLDWATER. . . . [Ambassador Smith said] we were allowed to continue with laser research and development. Is that your understanding?

General RYAN. Yes, Sir.

Senator GOLDWATER. Is it yours, too General?

General PALMER. My understanding is in the defensive area, R&D on such systems is basically prohibited.

Senator GOLDWATER. Prohibited?

General PALMER. Basically prohibited.

Senator GOLDWATER. Here is another point that we have trouble on, a very simple point.

General PALMER. Talking about defensive now.

Senator GOLDWATER. Ambassador Smith didn't delineate between the two: Offensive or defensive. I am interested in not particularly offensive because I think for our purposes we have made progress in this field, but I am thinking of the extent of research on laser that could result in a perfect ABM weapon. . . .

General PALMER. I would like to correct my statement. I was referring to the development of such systems. There is no limit or understanding of a limit on R&D in the futuristic systems, but [it] would require an amendment of the treaty or further agreement to deploy such a system. (Hearings 432–33.)

In this exchange, Palmer seems to take the position that only the deployment of future systems is banned, a position in accord with the "broad" interpretation of the Treaty. He does not indicate at this point that Agreed Statement D and its deployment-only ban is limited to fixed land-based systems.

In addition to this testimony, comments made by several Senators are relevant. During the testimony of General Palmer, the following exchange took place:

Senator DOMINICK. . . . There isn't any ban, as I understand it, on research and development on either side?

General RYAN. That's right.

Senator DOMINICK. So, therefore, the onsite inspection is no different; the offsite inspection is not different now than it was before?

Senator JACKSON. Yes, but under article V of the ABM Treaty "Each Party undertakes not to develop, test or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based."

Senator GOLDWATER. Fixed based.

Senator JACKSON. The fixed-based ABM is exempt. . . .

Senator GOLDWATER. We could then replace the Sentry with the laser if it became effective?

Senator JACKSON. The prohibition runs to sea based, air based, space based, or mobile land based ABM's.

Senator GOLDWATER. Not fixed land?

Senator JACKSON. That's right. That is exempt. I am just pointing this out. . . .

General PALMER. Let me try to clarify that, Senator Jackson. The treaty, as you have just read, does limit radars, launchers, and missiles; it does not limit R&D on futuristic systems. We could not deploy such a new system, however. . . .

While these comments draw a distinction between fixed land-based systems and other types of systems, they do not distinguish between current and future technologies. Article V. undoubtedly bans development and testing of components based on current technology. Fairly read, Senator Jackson's comments do not address future systems. The difference he was noting—between fixed land-based and other basing modes—derived from the treatments in Article III and Article V of fixed land-based systems; it could reasonably be read to have no bearing on Agreed Statement D's treatment of future systems. General Palmer's statement, does, however, deal with the current-future distinction. His comments indicate that systems based on radars, launchers, and missiles are regulated by Article V; but they also appear to suggest that future devices are dealt with separately, and that only their deployment is banned.

In sum, throughout the Congressional hearings, Ambassador Smith consistently took the position that only the deployment of future systems was banned. At no point did Smith suggest that Agreed Statement D was limited to fixed land-based systems or components. Different positions were taken by Dr. Foster and General Palmer, but these statements lack the authority of Smith's interpretation, as their authors were not involved in the drafting or negotiation of the Treaty. Moreover, General Palmer's statement cannot fairly be taken as his definitive interpretation. At a different point in his testimony, he takes what appears to be a contrasting position, that the deployment-only ban, and by implication Agreed Statement D, applies to all futuristic systems, not just fixed land-based systems. Senator Jackson's comments do not appear to address future systems.

3. Committee report.—Both the House and Senate Reports dealing with the future systems issue. The Senate Report, however, does so only by reprinting Secretary Rogers' report on the Treaty as the description of the agreement's terms. The House Foreign Affairs Committee Report treats the issue more directly and independently. In summarizing the provisions of the ABM Treaty, the report states: "The two nations additionally agree to ban development, testing or deployment of sea-based, air-based, space-based or land-mobile ABM systems. Nor will they deploy ABM systems based on new technology without prior discussion and amendment of the Treaty."—(1972 Documents on Disarmament 557)

This statement follows the same pattern as the descriptions by Smith and Rogers: listing other prohibitions, then discussing the non-deployability of future systems, implicitly distinguishing between the prohibitions of Article V and the prohibitions of Agreed Statement D.

4. Floor debates.—The floor debates are ambiguous on the future systems issue; the few statements addressing the question can be read to support both theories. On one hand, Senator Buckley opposed the Treaty at least in part because of his reading of its limitations on future technologies. Buckley read Article V as applicable to future systems: "Thus, the agreement goes so far as to prohibit the development, test or deployment of sea, air or space based ballistic missles defense systems. This clause, in article V of the ABM treaty, would have the effect, for example, of prohibiting the development and testing of a laser type system based in space which could at least in principle provide an extremely reliable and effective system of defenses against ballistic missiles. The technological possibility has been formally excluded by this agreement.—(1972 Cong. Rec. 26703.)

Similarly, Senator Thurmond felt that "[u]nder the treaty, we also give up the right to deploy any land-based ABM systems of a new type, should they be developed. At the same time we undertake 'not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based.'" Thurmond's comment could be read to indicate development of future systems, other than fixed land-based, was prohibited.

On the other hand, Senator Fong was of the view that the Treaty "[a]llows research and development on ABM systems to continue, but not the deployment of exotic or so-called future systems. (1972 Cong. Rec. 26707) While "research and development" may not be equivalent to development and testing, Senator Fong's indication that only deployment is banned suggests he viewed Agreed Statement D as regulating future systems.

Given the presence of statements on each side of the issue, and the possibility that opponents of the treaty may have tried to exaggerate its limitations, one cannot draw reliable conclusions from the floor debates.

B. Post-Ratification

1. Early statements.—Early post-ratification statements tend to support the "broad" view of the Treaty's restrictions. On October 23, 1972, shortly after the Treaty was ratified, then-Ambassador Bush presented the following analysis to the United Nations General Assembly: "A number of important qualitative restraints are also specified [in the Treaty]. For example, the parties have accepted limitations on development and testing. They have agreed not to develop, test, or deploy ABM systems or components which are sea-based, air-based, space-based, or mobile land-based; ABM launchers for launching more than one interceptor missile at a time; automatic or semiautomatic or other similar systems for rapid reload of ABM launchers; and multiple independently guided warheads for ABM missiles. They have also decided not to deploy new ABM systems based on other physical principles, such as those which employ laser beams, for example, without discussion and agreement on their limitation."—(67 DOS Bulletin 74 (1972).)

Like previous statements of Smith and Rogers, Bush's statement indicates that future systems were treated distinctly, that Agreed Statement D was not limited to fixed land-based systems, and that Agreed Statement D was not a superfluous but a significant part of the Treaty.

Two 1973 statements—the ACDA Annual Report of January 31, 1973 [1] and Secretary Rogers' Foreign Policy Report of April 19, 1973 [2]—treat future systems in much the same way as the Bush statement, thereby adding further support for the "broad" interpretation.

2. Later statements.—By about 1978, the ABM Treaty's provisions had come to be viewed somewhat differently. Several statements made since 1978 support the "restrictive" theory.

The first indication that the Treaty banned the development and testing of future systems came in a book written by John Rhinelander in 1974. He took the position that the Treaty's "overall effect . . . is to prohibit any deployment of future systems and to limit their development and testing to those in a fixed land-based mode." (Salt: The Moscow Agreements and Beyond 136 (M. Willrich & J. Rhinelander eds. 1974)) Rhinelander has subsequently reaffirmed that he takes the "restrictive" view of the Treaty. (See T. Longstreth, J. Pike & J. Rhinelander, The Impact of U.S. and Soviet Ballistic Missile Defense Programs on the ABM Treaty (March 1985))

The first Administration statement reflecting the "restrictive" view, however, did not come until 1978. The Fiscal 1979 Arms Control Impact Statement, filed with Congress in 1978, assessed the arms control impact of particle beam weapons programs. It noted such weapons have ballistic missile defense potential and thus were affected by the ABM Treaty. The impact statement thus discussed the Treaty, offering the following analysis of its provisions: "Article V . . . prohibits the development, testing or deployment of all types of ABM systems or their components that are sea-based, air-based, space-based, or mobile land-based. Article III . . . prohibits all deployment of ABM systems or their components except for the two land-based deployments permitted pursuant to such article. Article II defines an ABM system . . . Thus, [particle beam weapons] used for [ballistic missile defense] which are fixed land-based could be developed and tested but not deployed without amendment of the ABM Treaty, and the development, testing, and deployment of such systems which are other than fixed land-based is prohibited by article V of the treaty."—(Fiscal Year 1979 Arms Control Impact Statements (Committee Print 1978).)

The Arms Control Impact Statements for fiscal years 1980 to 1986 offer similar assessments of the ABM Treaty. (See also Dep't of Defense, Report to Congress on the Strategic Defense Initiative app. B (1985).)

These later statements are directly supportive of the "restrictive" theory. They view Article V as regulating future as well as current systems, prohibiting their development and testing, as well as deployment. Moreover, these statements suggest that Agreed Statement D is limited to fixed land-based systems. This view increasingly was adopted as a standard interpretation. Ambassador Smith appears to have first offered this view in his 1980 book on SALT I, "Doubletalk: The Story of SALT I."

The "restrictive" view, however, has never been uniformly accepted. For example, ACDA's periodic compilation of arms control agreements has consistently supported the "broad" view of the Treaty. Every edition since SALT I (1975, 1977, 1980, and the most recent edition in 1982) offered the description of the ABM Treaty referred to in the Summary. ACDA's analysis is consistent with the "broad view." Specifically, their discussion of the Treaty provisions notes that "[s]hould future technology bring forth new ABM systems 'based on other physical principles' than those employed in current systems, it was agreed that limiting such systems would be discussed, in accordance with the treaty's provisions for consultation and amendment." (ACDA, Arms Control and Disarmament Agreements 138 (1982 ed.)) Moreover, in introducing SDI, President Reagan referred to the ABM Treaty as banning only deployment. In a 1983 news conference, responding to a question concerning potential ABM Treaty limits on SDI, the President noted that SDI "doesn't violate the ABM treaty. . . . The ABM Treaty has to do with deployment." (Public Papers of the Presidents: Ronald Reagan 448 (1983))

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[1] The ACDA report offered the following analysis of the Treaty: "Another important element is the agreement that if future types of ABM systems or components based on physical principles different from present technology become feasible, specific limitations thereon will be a subject to discussion and agreement in accordance with treaty provisions regarding amendments. An example of such a future system would be one depending on the use of laser beams for destruction of missile reentry vehicles."—(1972 Documents on Disarmament 875.)

[2] In its summary of the SALT agreements, the Report states: "The treaty also provides for important qualitative limitations on ABMs, including an agreement that ABM systems based on physical principles different from those of existing systems should not be deployed under the treaty in its present form."—(1973 Documents on Disarmament 181.)

The record of post-ratification statements is thus mixed. The earlier statements continue to support a "broad" reading of the Treaty. Several later statements present a contrasting view, accepting the restrictive construction. At no time, however, was there a universal interpretation. Indeed, the one document that tracks the issue over the 1972-82 period—the ACDA publication "Arms Control and Disarmament Agreements"—appears to reflect that future systems are regulated only by Agreed Statement D.

CONCLUSION

The overall record of U.S. interpretative public statements, like the Treaty language and negotiating history, is mixed. Those statements made at or near the time of the Treaty's signature and ratification offer fairly consistent support for the broader interpretation now adopted as USG policy. In contrast, several later statements favor the "restrictive" view of the Treaty.

Under accepted principles of contruction, those statements made nearer the Treaty's drafting should be given more credence, and later statements accorded less weight.

Contemporaneous contructions are generally considered better guides to discerning an agreement's true meaning than later ones, especially those that take place in contexts which could provide alternative explanations for the statements made. Furthermore, the earlier readings in this instance were carefully considered, and delivered in the context of presenting a new agreement to both Congress and the public.

With these principles in mind, the "broad" view of the Treaty has as strong a basis as the "restrictive" view for being called "traditional" or "accepted." U.S. statements made between signature and ratification—the period closest to the Treaty's actual drafting and negotiation—consistently advanced the broader interpretation. Prepared statements made during the ratification process also provide strong support. Finally, early post-ratification statements reaffirm the construction. Later statements that clearly adopt the restrictive view make it inappropriate to claim that any view had been authoritative until the President's recent decision that the broader view is wholly justified. On the other hand, the record clearly refutes the proposition, advanced by opponents of SDI development and testing, that the USG has suddenly changed a view of the Treaty consistently advanced since 1972.

Senator WARNER. This is my last question within the 5-minute limitation prescribed for each member.

In the initial realm does the broad interpretation of the ABM Treaty change the administration's finding that the Soviets are in violation of the ABM Treaty as a result of construction of the Krasnoyarsk radar construction and preparation of a base for a nationwide ABM defense?

Judge SOFAER. Absolutely not. The Krasnoyarsk radar is prohibited by other provisions in the treaty, and a clear understanding, and everyone has recognized that it relates to the heart of the treaty that they are attempting to create a territorial defense.

Senator WARNER. Senator Hart.

Senator HART. As I understand your remarks, your position is that the three previous administrations, Presidents, Department of State and military leaders, were not wrong as such, but the issue never arose. That is, the question during those three administrations was never raised—no one ever interpreted the treaty narrowly or broadly one way or the other.

Is that correct?

Judge SOFAER. That is probably a good characterization, Senator. Very few Presidents have gone on record as to the meaning of the ABM Treaty insofar as it relates to SDI.

Senator HART. Weren't there some policies pursued during those three administrations that reflected a point of view about the breadth of the treaty?

Judge **Sofaer**. Not in this connection. The policy of pursuing only a research program as part of SDI does not necessarily imply a narrow view of the ABM Treaty.

The policy of research was intentional, it was a considered decision by the President and the Congress to pursue research until we got to the point of seeing what could be achieved and what would be feasible, both financially and otherwise.

Senator **Hart**. To your knowledge, at no point during that time of those three administrations was the issue raised and addressed on a policy level?

Judge **Sofaer**. There are many statements relating to how the ABM Treaty impacts upon future systems and components. SDI, you will recall, is a relatively recent program. Only in the last 3 years or so have we had statements connecting SDI and ABM.

Senator **Hart**. We have had a decade, at least, of research relating to ballistic missile defense and other technologies.

Judge **Sofaer**. Since there was never a question of research being in violation of the ABM Treaty, the matter was never addressed as such. The early statements, as I told you, support, at least are consistent with, the broader view, because they all stress agreed statement D as the source of restrictions on future systems and components, not article V.

Senator **Hart**. So, the question that has been raised by some that previous administrations were wrong is, in effect, irrelevant according to your point of view?

It is not a question of right or wrong? It never was an issue?

Judge **Sofaer**. I do not accept the characterization they were wrong. Mostly they never said anything. The statements that were made are, generally speaking, consistent with the broader view.

The statement made by Secretary Rogers early on, the statement made by Ambassador Smith, himself, three or four statements made by him are all consistent with the broader view.

Indeed, I remember reading when President Reagan announced the SDI Program and the press conference that followed it, he made a statement that was explicitly consistent with the broader view, where he talks about not going to deployment without looking at the ABM Treaty and making sure we are acting consistent with it, stressing the word "deployment."

Senator **Hart**. You could interpret that either way.

Judge **Sofaer**. I am not suggesting that these statements only support the broader view. That is not my purpose. I am simply saying that the notion that there has been a consistent view for 13 years in the Government and that it has been the restrictive view and that has always been the explicit, clear policy of the United States just has no basis.

Senator **Hart**. Finally, is this a matter that is questioned, an appropriate question to be brought before the Standard Consultative Commission?

Judge **Sofaer**. It may well be. I cannot opine on that in any authoritative way, but it would seem to me, reading the treaty, that it could be brought there.

Senator **Hart**. Who could?

Judge **Sofaer**. Either party could bring it.

Senator **Hart**. Who on our side can?

Judge **Sofaer**. If you read the treaty, the language would seem to suggest that this is the kind of thing you can bring there. It relates to the interpretation of the treaty.

Senator **Hart**. If somebody in the administration should make that decision, who would it be?

Judge **Sofaer**. The Secretary of State would have to make that decision and Paul Nitze could be part of that decision.

Senator **Hart**. He has rendered no opinion on it?

Judge **Sofaer**. It is not a question of opinion. No one has raised it yet so far as I know with the SCC.

Senator **Hart**. Has anyone raised it with the administration and has anyone in the administration reflected a point of view on whether it might be brought before the SCC?

Judge **Sofaer**. No one in the administration so far as I know has made such a decision or addressed himself to that question.

Senator **Hart**. Thank you, Mr. Chairman.

Senator **Warner**. Senator Cohen.

Senator **Cohen**. Judge, under your interpretation, the United States and the Soviet Union are permitted to test sea-based exotic ABM systems?

Judge **Sofaer**. Develop and test, yes.

Senator **Cohen**. And air-based?

Judge **Sofaer**. Yes.

Senator **Cohen**. And mobile-based?

Judge **Sofaer**. But only if they are based on other physical principles. All these years are conditioned on that. They cannot be based on the physical principles known to the negotiator in 1972.

Senator **Cohen**. Reading Senator Jackson's comments concerning the debate on the ABM Treaty, he said:

> Senator **Jackson**. Yes, but under Article V of the ABM Treaty each party undertakes not to develop, test or deploy ABM systems or components which are sea-based, air-based, space-based or mobile land based.
>
> Senator **Goldwater**. Fixed based.
>
> Senator **Jackson**. The fixed-base ABM is exempt.
>
> Senator **Goldwater**. Fixed based.
>
> Senator **Jackson**. The fixed based.
>
> Senator **Goldwater**. We could then replace the Sentry with the laser if it became effective?
>
> Senator **Jackson**. The prohibition runs to sea-based, air-based, space-based, or mobile land-based AMBs.

He went on to question General Ryan:

> General **Ryan**. It does not mean that fixed, land based cannot be developed.
>
> Senator **Jackson**. Yes, I said that. Now, what I am saying, General Ryan, is that you are prohibited from developing a system that is sea-based, air-based, space-based, or mobile land based?
>
> General **Ryan**. That is correct.

Senator Jackson ended up voting for the treaty based on the statements.

Then we have had Jim Buckley. He said:

> Thus the agreement goes so far as to prohibit development, test, or deployment of sea, air, or space-based ballistic missile defense systems. This clause in Article V of the ABM Treaty would have the effect, for example, of prohibiting the development and testing of a laser type system——

I believe you indicate they were not contemplating laser type systems at the time?

Judge **Sofaer**. No, I did not.

Senator **Cohen**. Finishing the Buckley statement:

> Testing of laser type system based in space which could at least in principle provide extremely reliable and effective system of defenses against ballistic missiles. The technological possibility has been formally excluded by this agreement.

Here we have proponents of the ABM Treaty ratification arguing that the articles prohibit it. We have the opponents saying it prohibits. But you say the document does not support it. Which leads me to the conclusion the ABM Treaty itself really is null and void for all practical purposes in dealing with this issue.

Judge **Sofaer**. I am not led to that conclusion. Those statements are in the memorandum that are submitted to the committee. I do not know whether I found every single statement.

Senator **Cohen**. These are congressional records.

Judge **Sofaer**. I understand that. Let me address myself to those specific statements, the Jackson statement and the Buckley statement.

In the Jackson statement there was an exchange. First of all, the Senators draw a distinction between fixed land-based systems and other types of systems, but they do not in their discussion distinguish between current and future technologies.

Article V undoubtedly bans development and testing of mobile components based on current technology. Now, in that exchange that you referred to, further on down, Senator Jackson said fixed land-based systems are exempt.

I am just pointing this out, and then General Palmer said:

> Let me try to clarify that, Senator Jackson.
>
> The treaty, as you have just read, does limit radar launchers and missiles; it does not limit R&D on futuristic systems. We could not deploy such a new system, however.

Now, General Palmer's statement does deal with the current future distinction. His comments indicate that systems based on radars, launchers, and missiles are regulated by article V, but that future devices are dealt with separately and that only their deployment is banned.

Now, that is one argument. I will be the first to concede that it is an argument that is one-sided, but I think that one can take little pieces of a legislative history and raise arguments, one-sided arguments, one way or the other.

Senator **Cohen**. These are not pieces, you have a major figure on the Senate Armed Services Committee, and I believe Mr. Perle was working for the Senate at that time. I assume he played an important role in helping the Senator to understand what he thought he was voting on.

Then you have Senator Jim Buckley, who was a highly regarded member of the Senate, voting against it because he believed, very sincerely apparently, that it was banned—that he thought there was a moral issue involved, that it was immoral to prohibit the testing and deployment of these future laser systems.

Judge **Sofaer**. Senator Buckley's statement was the statement of an opponent of the treaty and his opposition to the treaty was not based simply on that one provision. He opposed the treaty on several different bases, and like many opponents, he may have been exaggerating the treaty's coverage in order to justify his opposition.

Senator COHEN. So, he was wrong at least in that aspect when he said the fundamental question or morality involved here, he was wrong because the issue of morality was not accurate?

In other words, he was morally capable of defending our cities and people by testing and development of such systems?

Judge SOFAER. It is my job to look at these statements and see what they are worth in some rigorous analysis. I do not know, whether he is right or wrong or moral or immoral; that is something I will leave to other higher authorities.

Senator COHEN. The search for congressional intent is not an easy job.

Judge SOFAER. You ask yourself why did an individual Senator say the things he said when you analyze legislative history. That is an opponent of the treaty. He opposed the treaty on many grounds. An opponent of a treaty or statute will tend to exaggerate the coverage of a provision in order to justify his position.

Senator COHEN. What about Senator Jackson's understanding?

Judge SOFAER. This is Senator Buckley I am talking about.

Senator Jackson's statement, I think, was a statement that stressed that they failed to look at the distinction between current and future technology clearly enough and consciously enough.

It is a difficult problem. When General Palmer came in with his clarifying comment, I think that helped to focus the issue somewhat more.

Senator COHEN. Was Palmer part of the negotiating team?

Judge SOFAER. I do not know if he was part of the team. I do not think he was. He was here and was aware of what was going on.

Senator COHEN. Did you interview the negotiating team?

Judge SOFAER. I have never interviewed all the members of the negotiating team. I did go to Paul Nitze with my work and laid it out before him, and he told me he thought I was right.

Senator COHEN. Did you go to Gerard Smith or Sidney Graybeal or John Rhinelander?

Judge SOFAER. I have not gone to any of those gentleman, although Ambassador Smith and I have been on the road together now.

If I may finish, Mr. Chairman, my statement on Senator Buckley's statement. I think it is important to understand my point about an opponent's statement on the floor being subject to an evaluation that diminishes the value of such statement. It is one that is accepted in the courts.

In *Holtzman* v. *Schlesinger,* the Supreme Court stated as follows:

> It is well established that speeches by opponents of legislation are entitled to relatively little weight in determining the meaning of the act in question.

I can give you other quotes along the same line.

Senator COHEN. I probably feel the same way.

Judge SOFAER. I would also say there are other Senators that have different statements. For example, Senator FONG was of the view that the treaty "allows research and development on ABM systems to continue, but not the deployment of exotic or so-called future systems"; that is in the 1972 Congressional Record, page 26707.

Senator COHEN. Could I go back to General Palmer's testimony again.

Following the colloquy you mentioned there is a statement:

> General PALMER. A concept that does not prohibit the development in the fixed land-based ABM system. We can look at futuristic systems as long as they are fixed and land based.

Judge SOFAER. Yes. I found that statement and it is discussed in my memorandum as well.

I could indicate to you, Senator Cohen, that there was a very eminent and brilliant general here who testified only a week or so ago and who said words that could be interpreted to be inconsistent with the broader interpretation of the treaty, even though he was well aware of it.

One has to sit down with somebody who has made a statement of this kind and confront him clearly with the options in order to get a definitive reading.

I am not contending in my memorandum that the broader view is the definitive reading, that everything is only consistent with the broader view. I am simply saying that there is nothing, there is really no basis for saying that the restrictive view is an authoritative view.

Senator COHEN. I am just trying to clarify what the Senate did in response to professional testimony. When General Ryan comes before Senator Jackson and Jackson said:

> Yes, I said that. Now, what I am saying, General Ryan, is that you are prohibited from developing a system that is sea based, air based, space based, or mobile land based.

General Ryan said, "That is correct." Then he went on to say "We can look at futuristic systems as long as they are fixed and land based." That was testimony presented to the committee in 1972.

Judge SOFAER. There was other testimony by other generals that you will find supports the broader view. That is all I am trying to establish, that there is no authoritative view to be derived from the external record.

Senator WARNER. Senator Nunn.

Senator NUNN. Thank you very much.

Judge, see if I am correct in following your line of reasoning here.

It is my understanding that one of the basic foundations of your reasoning is that an interpretation rests with the reading of the first sentence of article II and that is related to the definition of the ABM system which you believe should be read narrowly, applying only to those ABM systems based on 1972 technologies.

Is that correct so far?

Judge SOFAER. Only those systems and components as described and others that could be developed that are like them based on then-known principles, yes.

Senator NUNN. You then reject the view that this definition in article II should be read functionally, that is, that it covers all ABM's, past, present and future? You would reject that?

Judge **Sofaer**. I do reject it entirely. I accept it insofar as it is part of the definition. I accept it, but then it is qualified further, it is a functional definition that is qualified further by the definition of what a system is, composed of these three components.

Let me give you an example of what I mean. Let us say that, based on then-current physical principles, a new type of radar was developed or a new type of missile. That would be covered if it served the same function.

So, the functional definition would apply, but it would apply only because the new system, the new component, was based upon then-known physical principles.

Senator **Nunn**. You are saying that new technologies are not covered and by doing that don't you have to get to the conclusion that the word, the comma after the word "trajectory" in article II should be read "and"?

In other words, if those are just illustrative rather than connected with "and," it seems to me that your logic falls, I am assuming you are saying in article II, the first sentence:

> For the purpose of this treaty, an ABM system is a system of counterstrategic ballistic missiles or their elements in flight trajectory * * *

Judge **Sofaer**. I do not agree with you, Senator, because I think that, in fact, it is the restrictive view that does not make any sense in those terms. There would be no need to talk about "currently consisting of."

If this was intended to be purely a functional definition, all you would have to do is put a period after "trajectory." You do not have to talk about what the systems currently consist of. The Soviets insisted——

Senator **Nunn**. I am looking on page 5 of your opening statement. You say:

> The provision can more reasonably be read to mean that the systems contemplated by the treaty are those that serve the functions described and that currently consist of the listed components.

That is what I am saying.

Judge **Sofaer**. Yes.

Senator **Nunn**. You are reading the comma as meaning "and"?

Judge **Sofaer**. No; that part I do not agree with.

Senator **Nunn**. That is what you say here.

Judge **Sofaer**. Senator, I gave an explanation for my position then. I do not say you have to put the word "and" in. It makes more sense to put the word "and" in, in light of the fact that you do not need any of the words after that comma at all.

Senator **Nunn**. Are you saying it makes more sense to use the word "and"?

Judge **Sofaer**. Yes; to read it as though the word "and" was there, certainly.

Senator **Nunn**. That is my question. Let me ask you this question.

Do you take the same view of all other references in the treaty to the definition of ABM systems in other articles?

Is your definition of ABM systems consistent throughout the treaty as you have applied it in article II?

Judge SOFAER. Yes, except in agreed statement D where you have the qualifying language "based on other physical principles."

Senator NUNN. Article V, paragraph (1), also uses the words "ABM system."

Would that same definition apply in that paragraph?

Judge SOFAER. Yes.

Senator NUNN. Let us look at article III. The words "ABM systems or their components" as applying to conventional ABMs, do you use that in the same context? Do you define it the same way?

Judge SOFAER. Yes, sir.

Senator NUNN. Wouldn't it follow then that article III would then impose no barriers to deploying ABM systems or components based on other technologies that did not exist then?

Judge SOFAER. Yes, sir, other physical principles, based on other physical principles.

Senator NUNN. So, there is no barrier to deployment of any system based on other physical principles in article III?

Judge SOFAER. Other than agreed statement D. One of the arguments made by negotiators to the Soviets——

Senator NUNN. Agreed statement D does not limit deployment, as I understand it. It says it will have to be discussed.

Judge SOFAER. It does limit deployment. We concluded that in the executive branch. It says that you cannot deploy, the parties agree not to deploy.

Senator NUNN. It says "except as provided in article III." You have just established that article III does not limit that deployment because if article III and article II have the same definition, then article II fails in terms of its limitation.

Therefore, there is no limit on deployment in article III of any systems in that definition by your own logic.

Judge SOFAER. The limits of article III would eliminate all need not only for agreed statement D, but for article V as well, if article II applies to systems based on future physical principles. My reading of article III allows both article V and agreed statement D to serve a purpose. Agreed statement D serves a purpose of preventing deployment of systems based on future principles.

Senator NUNN. How does article III serve a purpose, then, because by your definition it would not limit future systems, deployment of future systems, and it does not.

Judge SOFAER. Because article III relates to fixed land-based systems only.

Senator NUNN. I guess, Mr. Chairman, we will have to vote.

Senator WARNER. We will resume with final questions when we return.

Senator NUNN. Let me wrap this up.

You are applying your definition consistently all the way through the treaty? Your definition of article III flows throughout the treaty, as you see it?

Judge SOFAER. I have attempted to do that. I think my interpretation is more consistent and gives meaning to each of the provisions where the more restrictive view does not.

Senator NUNN. Thank you.

Judge SOFAER. There may still be complications in the interpretation, Senator Nunn.

Senator NUNN. I have a lot more questions.

Senator WARNER. We will start with the Senator from Indiana when we return.

[Recess.]

Senator WARNER. We will resume.

Senator Quayle.

Senator QUAYLE. I would like to congratulate the judge on what I think is a detailed and, obviously, a most exhaustive research on this particular issue that has ever been done. I am aware of your legal background. I applaud you for a very comprehensive report. I think you have done a darn good job.

I wanted the record to show that some of us are deeply indebted to you for this service and appreciate the background and the objectivity; also, I might add, the conclusions that you have developed.

I just want to pick up on the last point that Senator Nunn was getting into.

Judge SOFAER. Senator Nunn was making a good point that I did not quite fully grasp. Now I am beginning to understand it.

Senator NUNN. What I am saying is if you apply his definition all the way through, not just article II, the other articles of the treaty become virtually meaningless and you reach the conclusion that the Defense Department reached that exotic technology is not only to development and testing, but it is no part of deployment either.

I do not see where you stop short of where the Defense Department came to, their lawyer, based on their logic.

Senator QUAYLE. I think their counsel agrees with the State Department counsel, the fact that agreed statement D does in fact prohibit deployment until discussion or you have withdrawal from the treaty.

Senator WARNER. Maybe the judge would want, on further reflection, to amplify his response to Mr. Nunn.

Do you wish that opportunity?

Senator NUNN. Wait just one second. Let me get my logic here.

Agreed statement D prohibits deployment as provided in article III. That is what it says. It says in order to assure fulfillment of the obligation as provided in article III.

The judge has just established that article III does not limit the exotic systems. If it does not limit the exotic systems in deployment in article III, then agreed statement D does not limit them either because it references article III.

Senator QUAYLE. The reason it references article III, the way I interpret it, is because article III allows for deployment of an ABM system. The thing that bars the deployment of an ABM system is article V.

Article V says that each party undertakes not to develop, test or deploy ABM systems or components which are sea based, air based, space based or mobile land based. Therefore, agreed statement D applies to article V and not necessarily article III because article V. is where you have absolute prohibition because therein, according to the history of the thing, we could not.

Do you agree with that?

Judge SOFAER. I think you are emphasizing Senator Nunn's point in a way, Senator.

Senator NUNN. Article III does bar deployment except in certain specified——

Senator QUAYLE. It allows deployment under certain conditions.

Senator WARNER. I will let you start fresh.

I was a law clerk to a Federal Judge and I had to go through these records to try to figure out what was said.

Senator COHEN. You know, they are all disregarded anyway.

Senator WARNER. I want the judge to have an opportunity, first, not on your time, to reply to Senator Nunn and then we can initiate——

Senator QUAYLE. What is the question?

Senator WARNER. Let Senator Nunn restate for the record the question and then allow the witness to reply.

Senator NUNN. I do not know whether it was a question.

Senator WARNER. It is an observation.

Senator NUNN. Observation that agreed statement D references article III and clearly states that its purpose is to carry out article III, or in order to assure fulfillment of article III, the judge has established by his testimony, in his opinion, basically it has the same definition as article II and, therefore, does not limit the future technology systems and, therefore, I think the conclusion you have to reach is that agreed statement D does not limit the deployment either.

Judge SOFAER. May I address that, Mr. Chairman?

Senator WARNER. Yes; of course.

Senator NUNN. Based on the judge's logic. I am following his logic to what I consider to be its conclusion.

Judge SOFAER. I do not think you will feel that way, Senator, I am sure, when this issue is worked out. I think, in fact, that is based ultimately on the notion that agreed statement D is written only with respect to fixed land-based missiles and systems. It is a dangerous proposition.

If you read it that way, you will find there is a very big logical hole in the system. If you read it the way I read it, I think you will see that everything really is covered.

Agreement statement D is not an hortatory statement, it is not an understanding such as we have in the common understanding. This is an agreed statement in which the parties used language similar to the obligatory language of the provisions of the treaty itself: "The parties agree."

Now, in agreed statement D, I contend the parties agreed to prohibit the deployment of all future systems and components, where fixed land based or any mobile system or component, until the parties have discussed the system or component together as provided for in the treaty and reached some kind of agreement on specific limitations.

The way it all fits is this. Article III relates to what is known, fixed land based and what is known. It sets out in a way the basic purpose that the parties had: let us prohibit the deployment of all ABM systems and components other than as we provide here. That is what article III was trying to do.

When the parties discussed future systems, the Soviets were repeatedly reluctant to accept any kind of limitation of what they did not know. They ultimately agreed to this provision because what the American negotiators were able to force them to agree to was, would not the limitation of article III be rendered meaningless if new systems were developed, new devices which are the equivalent of systems and components are developed and deployed?

So, they wrote this provision "in order to ensure fulfillment of the obligation not to deploy ABM systems and their components except as provided in article III of the treaty "in order to fulfill the parties' purposes in this treaty of having ABM systems and components that perform those functions deployed only a way provided in article III.

We agreed if new systems and components are developed, based on other physical principles, are created—they even used the word created, they did not want to use the word develop; they wanted to stress the fact that they might be talking about something completely different from what they were talking about and limiting the treaty.

If that happened, we would not undermine the heart of the treaty in article III, but we would agree before we deployed—not before we tested and developed, but before we deployed—to discuss this thing and reach an agreement on the specific limitation.

What did they mean there? It is very significant, Senator Nunn, if I may suggest. The specific limitations in the treaty are those limitations in articles III, IV, V, VI, and VII that make up the details by which the known systems, fixed land-based systems, were to be governed, testing ranges, et cetera.

So, what the Soviets and the United States were agreeing to is that they would go to this negotiation before they deployed and agree on a whole new set of specific limitations analogous to the treaty before any deployment could occur.

So, I read agreed statement D as containing an enforceable obligation not to deploy, a commitment by both sides not to deploy, and that it applies not only to fixed land-based, but to all sorts of systems and components based on other physical principles.

Senator **Warner**. Now you may take your 5 minutes.

Senator **Quayle**. In agreed statement D is there specific linkage to any of the specific articles III, V?

Judge **Sofaer**. In agreed statement D there is a reference to article III.

Senator **Quayle**. Is that the only article it applies to?

Judge **Sofaer**. That is the only article it refers to other than articles XIII and XIV where the limitations have to be discussed before deployment, of course.

Senator **Quayle**. So you do not think it refers to article V?

Judge **Sofaer**. I think that it implicitly excludes from any argument about article V any system or component based on other physical principles.

Senator **Quayle**. In that respect, it does relate to article V?

Judge **Sofaer**. Yes.

Senator **Quayle**. I wonder if you might tell us in your research why it is you think the Soviets did not want to agree on banning and restricting future systems based on other physical principles?

Why were they the ones that did not want this ban? Did that come up in your research?

Judge SOFAER. Yes; I do not have to guess about it. There were specific reasons by the Soviets that were given. It is no secret that in general it can be summed up as their unwillingness to deal with the unknown.

Let me put that concretely. The treaty talks about ABM systems and then defines it in terms of certain components, missiles, radars, and launchers. The Soviets in effect were saying to us. How do we know we are even going to be talking about those kinds of things? We do not know what we are going to be talking about.

They went into other arguments as well. The treaty, incidentally, also is designed to deal with those components talked about in article II(1). It is not designed to deal with unknown future components and systems.

So, they were very reluctant to deal with anything they did not know. Incidentally, it is clear when article V was agreed upon in negotiations, the Soviets had been objecting to dealing with future systems and components right up to that date and they went on objecting to dealing with future unknown systems and components after that date.

So, implicitly in the record you have the situation that suggests that article V was not intended to deal with those unknown systems and components that they were objecting to.

Finally, what happened was that our negotiators, I think, scored a very important victory and they finally got the Soviets to agree to address the future systems and components in agreed statement D.

Paul Nitze, I might add, was at the center of that success. He was the one who formulated the phrase "based on other physical principles." When I showed him my research and refreshed his recollection as to his role in that whole process, he agreed with my conclusions and I must say I was not too bashful to accept that as a reassuring factor.

Senator QUAYLE. Would you say, then, that the primary author from your research of agreed statement D would be Mr. Nitze?

Judge SOFAER. I would say more than anybody else in the record, Nitze played a crucial role in statement D.

Senator QUAYLE. It might be interesting to hear from Mr. Nitze.

Senator WARNER. We will take that under consideration.

Senator QUAYLE. So far, Senator Cohen brought up some points with Senator Jackson and Senator Buckley and General Ryan.

I also would like to comment that there are some other principles that are involved, there are statements that are somewhat ambiguous, to say the least, at least declared statements of today.

I guess we will be hearing from Mr. Smith later on who I know is opposed to the restrictive interpretation. He was asked concerning agreed statement D. I will just read:

> Mr. Chairman, there is an agreed interpretation with respect to ABM systems based on different physical principles and including components capable of substituting for those components at present—that is, launchers, missiles and radar components.
>
> If such new systems are developed and one or the other side wants to deploy them under the limitations of the Treaty, there would first have to be a discussion of the question in the Standard Consultative Commission we are proposing to establish

under this Treaty and then the Treaty would have to be amended before such novel ABM systems could be deployed.

Article III talks about research, test and development. They talk about deployed. Mr. Smith can answer that, but just reading that as we can read other statements, there is certainly some ambiguity here.

I am sure you probably have that statement. Maybe there are other things that support it. There is a question even at the hearings of what we are really focusing in on, testing and development. I am surprised that someone did not question this testing and development.

Senator **WARNER**. Will you give the reference for that statement?

Judge **SOFAER**. It is on page 5 of our memorandum.

Senator **WARNER**. What is the reference for our record?

Senator **QUAYLE**. June 23, 1972. House Armed Services Committee, July 25, 1972. I am reading from his memorandum. This sort of analysis says that agreed statement D in fact does allow testing.

Senator **WARNER**. You are reading from the memorandum of October 30, 1985?

Senator **QUAYLE**. I am reading from "Analysis of U.S. Post-Negotiation, Public Statements Interpreting"——

Senator **WARNER**. Above that right-hand corner?

Senator **QUAYLE**. I do not have any date on mine. There is one on this, October 30, 1985.

My point is, and I think it is a point we have to understand, that there was a lot of ambiguity on this particular point. You have this point, you have the point that Senator Cohen has brought up.

I have yet to see any refutation that argeed statement D, just reading it, does not allow for the testing and development. I guess I sort of ask you to put on your hat, and being a judge, what is the most compelling argument that the other side has, legal interpretation?

I know what yours are and I agree with yours, but coming from the other side, what is the hardest argument that you had to overcome to make certain that your interpretation was right?

What question did you have before you came to this conclusion?

Judge **SOFAER**. There is no single argument that I point to. I do not question the reasonableness, I think it is a reasonable position, the position advocated by Ambassador Smith. I have the highest regard for him. I do not need to say that here.

I think the strengths of his case are in the clear language of article V, the nature of the definition of article II, that is, the functional approach in article II and the argument that Senator Nunn just read, and that is wouldn't it be appropriate to look at agreed statement D as sort of an interpretative announcement as to what the parties understand will happen under the treaty if you look at articles I, II, III, and V, all taken together.

That is the way I would pitch their case. I think if you eventually get all my memos, you will see that the restrictive view is made, I think quite forcefully in my memos because I brought out the arguments on both sides and the legislative history, so to speak, on both sides.

There are aspects of the negotiating record that can lead, as I said in my testimony, one to understand why American negotiators, particularly 10 years after the event, would think that they had convinced the Soviets to ban all future systems.

In a nutshell, I can explain some of this confusion. It came out, I think, from a question that Senator Hart or Senator Nunn raised. That is the treaty does not only relate to the systems the parties knew about in 1972. It does relate to the future systems and components.

Article V does ban future systems and components, but only those based on physical principles known at the time. There could be a new ABM system or a new radar or a new missile or a new launcher that was devised and would come under the total ban of article V that was based on the physical principles known to the parties at the time.

Senator WARNER. Known by whom?

Judge SOFAER. Known by the parties, the scientists that represent——

Senator WARNER. On both sides?

Judge SOFAER. Yes, on both sides. The kind of physics they were using for ABM systems at the time.

Senator WARNER. If you will bear with the chairman, this is a fascinating and very informative session, but I am concerned about encroaching on the time of our distinguished next witness.

Could you inform the Chair and members of the committee of your availability today and the extent to which we can impose further on your time by virtue of votes?

We have two Senators who have been present and have not had an opportunity to pose questions to Judge Sofaer.

Ambassador SMITH. I can stand it as long as you can, Mr. Chairman.

Senator WARNER. Thank you very much. We will resume when we get back.

[Recess.]

Senator WARNER. We will resume.

Senator Levin.

Senator LEVIN. Thank you, Mr. Chairman.

Judge Sofaer, I have tried to follow your explanation of agreed statement D. I am having trouble with it still. Let me try again.

The first line says:

> In order to ensure fulfillment of the obligation not to deploy ABM systems and their components except as provided in article III of the treaty, the parties agree that * * *.

When in agreed statement D you read the term "ABM systems" in that first line, are they using the term ABM systems as it is defined in article III, in your opinion?

Judge SOFAER. Yes.

Senator LEVIN. So, they are talking about——

Judge SOFAER. As defined in article II.

Senator LEVIN. And also article III?

Judge SOFAER. The definition is in article II.

Senator LEVIN. Is that also used in article III?

Judge SOFAER. Yes. Article III talks about ABM systems as defined in article II.

Senator **Levin**. So that the first use of the phrase "ABM systems" in agreed statement D is the same as it was used in articles III and II?

Judge **Sofaer**. Right.

Senator **Levin**. Then the agreed statement goes on to say that "The parties agree in the event ABM systems based on other physical principles * * * are created in the future, specific limitations on such systems and their components would be" discussed and agreed to according to certain articles.

Would you agree if they did not agree to those limitations, that they would not exist?

Judge **Sofaer**. If limitations were not agreed to, limitations would not have been agreed to.

Senator **Levin**. Then the party would be free to proceed?

Judge **Sofaer**. No; absolutely not. Then it would be inconsistent with the fulfillment of the obligation not to deploy, stated in article III, which is the purpose of the treaty.

The purpose of agreed statement D is to prevent deployment other than in article III unless agreed to through the process provided for in agreed statement D.

Senator **Levin**. Don't you need the second half of that sentence—you said the first use of ABM systems in that paragraph, old systems, is defined in article III.

Now, the question is what is the meaning of the second half? You are saying then in the absence of an agreement on limitation that the parties are not free to develop?

Judge **Sofaer**. No; they are free to develop.

Senator **Levin**. Just deploy?

Judge **Sofaer**. Right, just deploy.

Senator **Levin**. You get that from the first sentence in agreed statement D which says "In order to ensure fulfillment of the obligation not to deploy"?

Judge **Sofaer**. From the spirit of the first phrase. Indeed, "in order to ensure the fulfillment," from that phrase, from the purpose of that phrase.

Senator **Levin**. Give your interpretation now that ABM systems as first used and agreed in paragraph (d) means as defined earlier in articles III and II, I do not see how the second part of the agreement has anything to do with an ensuring fulfillment of article III. It does not connect. It has nothing to do with ensuring a fulfillment of article III.

I have listened to you all afternoon, particularly in light of your statement now how you construe the definition of ABM systems the first time used in agreed statement D.

I do not see at all that the second half ensures fulfillment of the first sentence. Let me say that and go on.

Judge **Sofaer**. Could I make one observation?

That is that article II said that the definition in article II will apply to the use of those phrases throughout the treaty. You have to make a choice as to how you want to interpret it. It seems to me to be consistent throughout.

Senator **Levin**. I am also troubled by a number of others. One is what you do not include in your opinion. You have given the committee a memorandum which sets forth the basis for your findings.

You indicated today that you brought out arguments you felt on both sides of the issue.

I think you have left out some things in that memorandum which are significant.

Would you agree with me that what I am going to read to you is significant and it bears on the intent of the people who produced the treaty and ratified it?

First of all, the statement of the Defense Department on June 6, 1972, in answer to a question from Senator Goldwater where they said there are no restrictions on the development of lasers for fixed land-based ABM systems. That is what the Defense Department provided in answer to Senator Goldwater's question.

Would you agree that that is a significant statement bearing on the correct interpretation, there are no restrictions on the development of lasers for fixed land-based ABM systems?

Senator **Warner**. Would the gentleman give the date of Senator Goldwater's statement?

Senator **Levin**. June 6, 1972.

Senator **Warner**. Thank you very much.

Judge **Sofaer**. If I have not dealt with that and I found it, I certainly would have dealt with it.

Senator **Levin**. Do you agree that is a significant statement?

Judge **Sofaer**. Well, it is certainly one of the statements I would have considered and dealt with and analyzed along with all the others.

Senator **Levin**. That is not in your memo, is it?

Judge **Sofaer**. I do not know, It sounds similar to some of the things I discussed in the memo.

Senator **Levin**. What about this statement? This is an exchange between Senator Jackson and Senator Goldwater as follows:

> Senator **Jackson**. The fixed-base ABM is exempt.
>
> Senator **Goldwater**. Fixed based.
>
> Senator **Jackson**. The fixed base.
>
> Senator **Goldwater**. We could then replace the Sentry with the laser if it became effective?
>
> Senator **Jackson**. The prohibition runs to sea-based, air-based, space-based, or mobile-based ABMs.
>
> Senator **Goldwater**. Not fixed land?
>
> Senator **Jackson**. That is right. That is exempt. I am just pointing this out.

Now your memo to us stops right there, puts some dots at that point. I now want to fill in the dots for you. This is what Senator Jackson continues to say:

> In those other areas it it prohibited and development is also prohibited:

Do you think Senator Jackson's words at that point are significant, that development is also prohibited?

Judge **Sofaer**. If I left out those words, and I certainly should have left them in, I think we discussed this information.

I think what is also significant is General Palmer's statement thereafter clarifying.

Senator **Levin**. I want to end with General Palmer's statement. If there is any ambiguity in the statement, General Palmer clarified it in a paragraph that Senator Cohen read. I want to read one line beyond that because there is a significant statement of General Palmer beyond it.

> General RYAN. It doesn't mean that fixed, land based cannot be developed.
>
> Senator JACKSON. Yes, I said that. Now what I am saying, General Ryan, is that you are prohibited from developing a system that is sea based, air based, space based, or mobiled land based?
>
> General RYAN. That is correct.
>
> Senator JACKSON. I just wanted that; so the Chiefs went along with the concept here that involved——
>
> General PALMER. A concept that does not prohibit the development in the fixed land-based ABM system. We can look at futuristic systems as long as they are fixed and land based.

That is a critical sentence which you kind of made reference to in your brief, but in a very passing way and then went on to a long explanation. I want to add the next sentence.

> Senator JACKSON. I understand.
>
> General PALMER. The Chiefs were aware of that and had agreed to do that and that was a fundamental part of the final agreement.

That is a very clear statement by General Palmer, not at all ambiguous, which follows the statement which you think is significant, not before, but following it.

Judge SOFAER. I think they are all significant, Senator.

Could I put in perspective the statements in terms of the meaning of the treaty?

I have addressed myself to these statements by way of just demonstrating that there is no uniform interpretation that has been authoritative over the last 13 years. If you use these statements for deriving the true meaning of the treaty, that is even more hazardous.

These statements represent only the view of one party to a treaty in which there were two parties. I think that you have to look at the negotiating history and the language of the treaty itself to derive what the binding commitments are, the mutually binding commitments.

Senator LEVIN. I agree with that, Mr. Chairman.

I am wondering, because these questions are so significant, whether we can leave the record open for several days so that we can submit additional questions to the witnesses?

Senator WARNER. Without objection.

Senator Wilson.

Senator WILSON. Thank you very much, Mr. Chairman.

Judge Sofaer, I want to make certain that I understand, although I think you have been quite clear, at page 6 in your testimony you have, it seems to me, focused on the fundamental point that has occupied us most of the afternoon. I quote to you now from your statement:

> The existence of Agreed Statement D poses a fundamental problem for the restrictive view. Nothing in that statement suggests that it applies only to future systems that are fixed land-based: on the contrary, it addresses all ABM systems and components that are "based on other physical principles."
>
> Moreover, the restrictive interpretation would render this provision superfluous. If Article II(1) extended to all ABM systems and components, based on present as well as on future technology, then article III implicitly would have banned all future fixed land-based systems and components.

You go on to say, "Such an interpretation, by rendering portion of the treaty superfluous, violates accepted canons of construction."

Mr. Chairman, that, it seems to me is a critical point in this whole question of construction.

I would just ask Judge Sofaer whether or not, having made clear his own analysis and having stated that that analysis was then supported by what he found in this examination of the negotiating record, can you, without violating any security classifications, state that the interpretation was buttressed by what you found in the negotiating record to be the response of the Soviets to American negotators' pressure to do exactly the reverse?

In other words, if I understand your argument, you are saying that the negotiating record would indicate a fairly consistent pattern of refusal on the part of the Soviet negotiators to accept the urging of the American negotiators to preclude, to prohibit, as does article II with respect to the fixed land-based systems, future systems based on other physical principles; that there was a consistent pattern of pressure on the part of the American negotiators to achieve that and consistent refusal on the part of the Soviets to agree to preclude then unknown and yet undetermined technologies.

Judge SOFAER. Yes; they did not even want to deal with them, let alone preclude them.

What the American negotiators succeeded in convincing them was that the very purpose of article III which limits deployment of then known systems and components would be totally undermined if they did not agree to prohibit the deployment of the unknown systems and components based on other physical principles.

That came at the very end of the negotiation of the treaty. It was only then that they agreed to deal at all with the problem of future systems, at least insofar as I was able to tell, that are based on other physical principles. They had, as I said, dealt in article V and article III with future systems and components based on then known physical principles.

I think some of the confusion that is in the minds of people today and some of the confusion that exists over this whole issue stems from the fact that people remember having prohibited future systems and components and what has become unclear in the course of time is that the future systems and components that were prohibited and banned in article V were those based on known physical principles, but not those based on other physical principles.

Senator WILSON. I do have a question with respect to a point made on page 6 of your testimony. You state that:

"Read in this manner, the treaty establishes"—that is in the broad interpretation—the treaty establishes a coherent, nonredundant scheme that prohibits, and you list several schemes, among them, "development, testing and deployment of all mobile systems and components derived from current technological principles."

I understand that your specialty is law, but let me ask this. I recently read a front page newspaper story that reported that the Soviets are not only deploying mobile missiles, but also deploying mobile defensive technology around them.

Would it not seem clear that the language of article V(1), makes that patently prohibited?

Judge SOFAER. It would seem so. It was based on present physical principles, currently understood physical principles.

Senator **Wilson**. Mr. Chairman, I know of nothing that indicates that the technology that they are applying does not meet that standard.

Judge **Sofaer**. Anyway, that would be deployment. You are not permitted to deploy. If it is a component, even if it is based on other physical principles, you are not permitted to deploy it to serve the function of an ABM system or component.

Senator **Wilson**. That, it seems to me, Mr. Chairman, is a violation of the ABM Treaty that is perhaps of greater importance even than what we know at Krasnoyarsk.

Senator **Cohen**. I have one question.

Judge, you indicated it was not until 1983, when the whole SDI program really became the focal point of debate, that the restrictive interpretation really came to pass.

Judge **Sofaer**. Was advanced in a vigorous clear way.

Senator **Cohen**. I have copies of the Arms Control Impact Statement for fiscal year 1979. It says:

> Particle beam weapons used for BMD which are fixed land-based could be developed and tested but not deployed without amendment of the ABM Treaty, and the development, testing and deployment of such systems which are other than fixed land based is prohibited by Article V of the Treaty.

That was submitted in the Arms Control Impact Statement in fiscal year 1979. Then similar language in fiscal year 1980. So, as early as 1979 and 1980 they were saying it was specifically prohibited for those systems which are other than fixed land-based.

Judge **Sofaer**. I do recall there were statements in 1979. I think it really picked up after the SDI Program.

The statements in March were even more explicit that came out of the Department of Defense. Most of the statements advocating the restrictive view came out of the Department of Defense.

Senator **Warner**. Judge, one last question.

As lawyers we often talk among each other about our briefs and arguments.

Would you consider this a closed legal question?

Judge **Sofaer**. That is an ambiguous statement in itself. I feel confident about the advice I have given my principals. I ask myself the question in sort of a concrete way which made it more meaningful for me. Can you tell the Secretary and the President that the Russians are banned by this treaty from developing and testing systems and components based on other physical principles?

The clear answer to that question is no.

Senator **Warner**. Very well. We thank you.

Mr. Smith, thank you so much for patiently waiting. You will be joined by Mr. Rhinelander.

STATEMENT OF AMBASSADOR GERALD C. SMITH

Ambassador **Smith**. Mr. Chairman, I have a brief statement I would like to make. I would like to say at the start I have great respect for Judge Sofaer and admiration for a man who has sacrificed a lifetime tenure as a Federal judge to fight the thankless battles of bureaucracy in Washington.

I would like to stress that my criticism today is in no way addressed to him personally.

I am going to leave it to John Rhinelander to make the detailed case against the administration's unilateral revision of a 13-year-old treaty. It is my belief that the 1972 Senate consent to ratification was based on the earlier interpretation which persisted until last month and I also believe there was a meeting of the Soviet and American minds on this score.

I had the good fortune to be sitting in on almost all of these hearings that we have heard about today. I have a strong belief that the new version was not what the Senate was thinking about when it consented to ratification.

Post-treaty Soviet actions have been consistent with the earlier interpretation. Administration officials have stated that there are two claims to the contrary. The sole motive for the switch appears to be to ease foreseeable treaty impingement on the SDI weapons program which is aimed at nationwide defenses against ballistic missiles, an aim which, incidentally, is now outlawed by that treaty.

I would stress that the basic objectives of the ABM Treaty to outlaw nationwide weapon systems to counter ballistic missiles and the strategic defense initiative as presently programmed are in direct opposition. They cannot coexist for long.

General Abrahamson has testified that in about 5 years it will be necessary to "depart" from the treaty. Some officials speak of amending the treaty. To my mind that would be tantamount to having tried to amend the Volstead Act to permit the sale of liquor. The recent reinterpretation of the treaty is, I suppose, an effort to amend the treaty unilaterally as it becomes clear that the Soviets have no interest in liberalizing existing constraints. They seem to favor tightening the treaty.

The belated discovery of what was said to be the new and categorically correct interpretation of the treaty was somewhat marred a few days later when the administration announced that the legal interpretation would not be accepted as a guide for U.S. arms control policy, at least not for the time being.

No explanation was given for this curious and quick withdrawal from legal certainty. We were merely told that the question was moot. A view of the treaty apparently considered legally incorrect by the administration is to be followed.

Considered how fragile the situation now is when a government can speak with two voices about its international obligations—one legal and one political.

Last week the Secretary of Defense advised the President not to promise to keep to the present policy. How long will this issue remain moot? Can either party to the treaty rely on the present situation persisting?

As in the case of SALT II offensive weapons controls, the administration in the ABM Treaty change seems to be trying to preserve constraints on Soviet weapons while seeking freedom for American weapons development. In SALT II, I might say, this task is not made easier by our refusal to be legally bound through treaty ratification.

Faced with mutual charges of violations of offensive and defensive control arrangements, our failure to ratify the latest three arms control treaties, and with the recent unilateral ABM Treaty revision, the prospect for the arms control process appears bleak.

Nothing that I have read in today's communique from Geneva suggests much to negate that conclusion.

The administration's attitude toward the relationship of law to arms control was also shown in connection with the latest antisatellite test. Language in the fiscal 1985 Defense Authorization Act required the President to certify before any ASAT test took place that the United States was "endeavoring in good faith, to negotiate with the Soviet Union a mutual and verifiable agreement with the strictest possible limitations on antisatellite weapons."

Such a certification was made. Suing to block the test, Representatives George E. Brown, Matthew F. McHugh, Joe Moakley and John F. Seiberling submitted in the Federal District Court for Washington, DC, affidavits from two congressional advisers to the U.S. delegation to the arms control talks in Geneva.

Thomas J. Downey stated:

> To the best of my knowledge, no negotiation between the United States and the U.S.S.R. on limiting ASAT weapons is now in progress in Geneva.

Representative Esteban Torres declared:

> The United States has not proposed any restrictions on antisatellite weapons and is not preparing to propose such restrictions.

The court denied the motion for a temporary restraining order on the theory that the decision to test was a political question. The test was conducted. So much for the respect which the administration pays to arms control legislation.

A few words about procedure. The reversal of earlier administrations' views including the Reagan administration's that the treaty banned the development and testing of space-based systems was decided upon in secrecy without consultation with Congress, the allies, or, indeed, with the SALT team that negotiated the treaty, among which are a former Secretary of Defense, a retired Air Force lieutenant general, and a retired senior professional Ambassador.

We are hearing today about new physical principles, things that were not know about. It was perfectly clear to us that in 1972 the concepts of lasers and particle beam weapons and direct energy weapons were well known.

I recall an episode where one member of the delegation handed over to the Soviets a magazine article describing this type of technology. It is not something that was discovered just recently.

The one principal SALT delegate still surviving in Government service apparently subscribed to the traditional version until a few weeks ago. Perhaps more importantly there was no consultation with the other party to the treaty even though special machinery exists in the form of the Standing Consultative Commission to handle claims of alleged ambiguities.

It seems fair to ask if this was an appropriate way to change the supreme law of the land.

If, in the future, an administration shifts the present policy of following the traditional treaty construction to the novel and permissive legal position, I think a justifiable issue may arise permitting the courts to decide if the supreme law of the land can thus be changed by executive fiat.

Treaties are supposed to lead to some predictability about the future. This is especially important when it comes to programming Armed Forces for the future. Unilateral revisionism makes for uncertainty which is in the enemy of prudent force planning. This is compounded when, as is the case now, a nation supports two treaty interpretations—one legal and one political.

The ABM Treaty has strong support in the United States. Just a few weeks ago six former Secretaries of Defense urged the President not to take any steps further to erode this treaty. Unfortunately, their experienced advice was quickly rejected. Revision cannot help but erode the treaty.

The Soviets are now virtually defenseless in the face of our ICBM's. I think that fact is good for the security of the United States. The administration seems to want to change it—and even speaks of selling the Soviets technology to make our missiles impotent and obsolete.

That strikes me as a senseless policy. We should try to keep the Soviets defenseless and the best way to do that is to strengthen and not weaken the ABM Treaty.

Incidentally, we are told by the White House that we are 10 years behind the Soviets in strategic defense. If that is the case, why in the world would we issue a license to them to accelerate their work and extend it by a new treaty version? This is beyond my comprehension.

I was struck by a recent statement of the Secretary of Defense that even the probability of Soviet defenses would warrant increases in U.S. forces. Isn't this the strongest reason for not weakening the ABM Treaty and, incidentally, for doubting the administration's argument that SDI will lead to arms control?

The preamble to that treaty states in part "proceeding from the premise that the limitation of antiballistic missiles systems, as well as certain agreed measures with respect to the limitation of strategic offensive arms, would contribute to the creation of more favorable conditions for further negotiations on limiting strategic arms."

The President's March 12, 1983 program, on the contrary, is based on the premise that the decontrol of antiballistic systems will lead not only to limits on strategic arms, but also to the elimination of nuclear weapons.

Which of these two premises is closer to the truth? That is the basic question which faces this administration and will face it successors.

Thank you.

Senator **Warner**. Would you like to have Mr. Rhinelander's leadoff?

Ambassador **Smith**. I think that would be most useful.

STATEMENT BY JOHN B. RHINELANDER

Mr. **Rhinelander**. Mr. Chairman and members of the committee, I submitted a 41-page statement with 9 exhibits to the committee yesterday with a 6-page outline. I understand it was viewed as too long to reproduce.

I would ask that they be printed in the record of the hearing.

Senator WARNER. Yes; I was just acquainted with that fact. I apologize. I was not aware of the fact you had submitted a statement. It will be made part of the record.

[NOTE.—Exhibits are retained in committee files.]

Mr. RHINELANDER. Very good. It is a revised version of the statements I had prepared earlier for the House and Senate in the last 2 or 3 weeks.

I would like to point out some exhibits which are attached to it.

The first, which is exhibit E, is a chapter from a book which I wrote in 1972 and 1973. The book was published in 1974. That chapter has been generally viewed by those in the executive branch as the public reference on the interpretation of the ABM Treaty and also on the interim agreement. I have not reproduced the pages on the interim agreement.

During the last negotiating session on SALT I in Helsinki I prepared successive drafts of long memoranda, 60 to 80 pages long, interpreting both agreements. I understand they are classified top secret. I have not seen them since I left the SALT process in 1972.

I am absolutely certain, though, that the summary which is in the chapter I wrote in 1972 and 1973 reflects the advice available to everybody within the SALT delegation on what the interpretation of the treaty was.

I know my own files—I was told this a couple of years ago—which I left behind in Government have been lost, but there are copies of the memoranda, I know, in JCS, OSD and, I believe, in other parts of the Government.

I have been asked questions from time to time, including questions of why I changed a footnote on the second to last draft, in the last draft.

I would submit that that is the basic document which members of the executive branch were using in preparing testimony and particularly in preparing the submissions for the record of the hearing.

The other exhibit I wanted to mention is in July I attended a conference in Sweden and I wrote a long paper looking at the ABM Treaty and what I thought ought to be done constructively to strengthen it. That is not an issue before the committee today. That exhibit F does contain my fullest thoughts.

Let me make about five points and then I think we ought to turn to questions.

Senator HART. Mr. Rhinelander, I have a communication from former Secretary Elliot Richardson who notes he has also written to Senator Warner. He includes in his letter a document dated November 21 of this year entitled "Statement of Reinterpretation of the ABM Treaty" by four lawyers and former Government officials, submitted to the Senate Armed Services Subcommittee on Strategic and Theater Nuclear Forces. That is the only heading.

The four signers are the Honorable Erwin Griswold, the Honorable Shirley Huftsteder, the Honorable Elliot Richardson, and the Honorable Cyrus Vance. It is their intention, I think, to try to have this made part of the record. I would submit it for that purpose.

I got the impression somehow you might be offering it as part of your remarks.

Mr. RHINELANDER. I have a copy of it here and if necessary, I would like to request it be included in the record.

Senator WARNER. Without objection.

MILBANK, TWEED, HADLEY & MCCLOY,
Washington, DC, November 21, 1985.

Hon. GARY HART,
Russell Senate Office Building,
Washington, DC.

DEAR GARY: I am pleased to see that the Subcommittee on Strategic Forces of which you are the ranking member is holding hearings today on the very important issue of the recent re-interpretation of the ABM Treaty. I have joined with three other lawyers and former government officials expressing our deep concern about the arms control and legal implications of this action.

On behalf of the other signatories, I am writing to request that you include our enclosed statement in the printed record of the hearings of the Armed Services Subcommittee on Strategic and Theater Nuclear Forces. I have also written to Senator Warner concerning this request.

Thank you for your attention to our request. Please let me know if we can be of any further assistance to the Subcommittee in considering these crucial issues.

Sincerely,

ELLIOT L. RICHARDSON.

Enclosure.

STATEMENT ON THE REINTERPRETATION OF THE ABM TREATY BY FOUR LAWYERS AND FORMER GOVERNMENT OFFICIALS SUBMITTED TO THE SENATE ARMED SERVICES SUBCOMMITTEE ON STRATEGIC AND THEATER NUCLEAR FORCES

We are deeply concerned about the Reagan Administration's recent reinterpretation of the 1972 Anti-Ballistic Missile (ABM) Treaty, which is the most significant treaty limiting the arms race between the United States and the Soviet Union. By banning nation-wide defenses against ballistic missiles, the Treaty was the cornerstone of the SALT agreements and is equally crucial to present efforts to reduce the dangerous and wasteful nuclear arms race between the two superpowers.

The Administration's new interpretation would permit not just research but also development and testing of exotic space-based defense systems, such as those contemplated by the Strategic Defense Initiative (SDI). Under this view, the treaty banning anti-ballistic missile systems would end up allowing the development and testing of such systems on a scale that would dwarf anything the two sides have considered building until now. As Ambassador Gerard C. Smith, Chief Negotiator for the ABM Treaty, has said, the new interpretation would make a "a dead letter" out of the ABM Treaty.

We are gratified that in the face of strong opposition from our Allies and members of Congress, the Administration has stepped back somewhat from this new interpretation, claiming that since SDI involves only research, the new interpretation allowing SDI to proceed beyond research is a "moot" point. This view postpones the issue but does not resolve it, particularly since the Administration says that it continues to adhere to the new interpretation "in principle."

Having devoted our careers to the rule of law, we are concerned about not only the arms control implications of the Administration's action, but also the procedure by which it was taken.

The ABM Treaty, like all treaties, is legally recognized as the supreme law of the land. When the Senate approved ratification of the Treaty without qualification by a vote of 88–2, it acted on the clear understanding presented by the President, the Secretary of State, the Secretary of Defense, and the Chief Negotiator that the Treaty banned the development and testing of all space-based ABM systems and components, including "exotic systems" based on new physical principles. This view of the Treaty was understood by all, including critics like Sen. Jackson, who voted for the Treaty, and Sen. Buckley, who voted against it.

The Reagan Administration's new interpretation would amend the Treaty beyond recognition by eliminating a major constraint that has uniformly been regarded as an essential part of the Treaty since its ratification. For thirteen years every Administration, including the present one until now, has confirmed the view that the ABM Treaty prohibits the development and testing of all space-based ABM systems.

The law is clear in regquiring Senate approval of amendments that modify treaties. But this major modification of the ABM Treaty has been worked out by a few appointed officials, without consultation with the Congress (or our allies for whom the Treaty is of major importance). This new modification renders the Treaty virtually meaningless—solely through internal administrative action.

The Administration argues that its new interpretation is justified by ambiguities in the Treaty and the secret U.S. negotiating record. The Treaty wisely established the Standing Consultative Commission (SCC) for the specific purpose of resolving such ambiguities, and the SCC has successfully done so many times since 1972. The Soviets have accepted the historic U.S. interpretation. Assuming good faith on both sides, the SCC could quickly resolve this non-dispute.

The Administration's view of the secret negotiating record is adamantly disputed by Ambassador Smith and others who conducted the Treaty negotiations. In any case, negotiating records that were not presented to the Senate cannot override the understanding of the Treaty which was the basis of the Senate's approval of the Treaty.

A treaty that has made such a major contribution to our national security should be complied with in good faith, and ambiguities in the Treaty should be resolved under the procedures provided for in the Treaty. Unilateral repudiation of the settled interpretation of this Treaty in order to facilitate new weapons schemes undermines the rule of law on which the international system is based.

ERWIN N. GRISWOLD.
SHIRLEY M. HUFSTEDLER.
ELLIOT L. RICHARDSON.
CYRUS R. VANCE.

NOTE.—Erwin Griswold is former U.S. Solicitor General and Harvard Law School Dean; Shirley Hufstedler, former U.S. Court of Appeals Judge and Secretary of Education; Elliot Richardson, former U.S. Attorney General and Secretary of Defense; and Cyrus Vance, former Secretary of State and Deputy Secretary of Defense.

Mr. RHINELANDER. Mr. Chairman, let me make about five remarks.

As far as I am concerned, the treaty text is clear in terms of exotic systems and, to the best of my knowledge, the negotiating record fully reflects it.

Specifically, the development, testing, and the deployment of the space and other mobile-type exotic systems is prohibited by article V.

With respect to the fixed land-based systems, the development and testing is permitted, but the deployment is prohibited. I believe that is clear from the text of the treaty itself.

Absolutely critical to an understanding of the treaty is article II and those magic words "currently consists of," with a comma and not an "and." I want to make clear that comma is no accident.

As far as I am concerned, as far as the members of the SALT I delegation were concerned, wherever that term "ABM systems or components" is used throughout the treaty, it refers to whatever technology might be involved. That is particularly including article III. It says:

"No systems or components will be deployed except," and the exception then is in terms of the traditional kinds of technology which was then being looked at by both sides.

So that all that can be deployed in terms of fixed land-based mode are radars, interceptors, and ABM missiles.

My statement lays out, to the best I can recollect and put together after talking to other members of the SALT I delegation, how we developed the treaty in the context of the exotic systems. It is, I believe, the first time this has ever been laid out sequentially in public. I will not go through it.

The second point I would like to make is that the Armed Services Committee hearings, as far as I am concerned, make amply clear both the DOD understanding and understanding of members of this committee as to what the treaty means.

Sentor Levin quoted from the response made by Secretary Laird. I have quoted that entire response in my statement. That was done very early on in the Armed Services Committee hearings.

I respectfully submit that the statement by the Secretary of Defense should not be taken lightly. It is explicitly clear. To my knowledge, Soviet statements and conduct since 1972 have been entirely consistent with the United States interpretation.

I am the first to admit that at times the Soviet statements are implicit rather than explicit—frequently elliptical. But the statements start with their ratification statement of September 30, 1972, which was printed in Pravda.

Before this current controversy broke out, the Gorbachev interview in Time magazine is very clear and I again quote that in my statement.

Finally, after this controversy broke out, there was an extraordinarily detailed and lengthy statement by Marshal Akhromeyev, chief of the general staff of the Soviet Union, printed in the Washington Post in its entirety. I would commend that statement to you. That, though, was made after the controversy broke.

As far as I know, the Soviet conduct and Soviet statements post-1972 have been entirely consistent with the interpretation that we in the delegation took and which I submit was stated to the committee here.

With respect to the laws of the United States and general international law, the basic rule is that agreements are to be interpreted in good faith and in accordance with the ordinary meaning of their terms, objectives, and purposes. Subsequent practice is at least as important as the negotiating history in interpreting an agreement.

I submit to you what you have heard from Judge Sofaer today is really a selective reading of the classified negotiating history without taking any look at all as to what has happened since that time. I would say the United States record and the Soviet record are entirely consistent with the broad ban in article V.

If there had been any question or concern that the Soviets did not feel they were bound, the proper way to deal with the question would have been to submit it to the SCC. One of the stated purposes of the Standing Consultative Commission is to deal with questions of interpretation. If there was any question, that should have been submitted and the request or demand should have been made to agree in writing to make it more specific, if that was thought necessary. To my knowledge, that has not been done.

As you know, our SCC Commissioner is really an instructed agent. He works only on instructions from Washington. There is no hint that I know of, that our delegate, who is an excellent man, has been asked to close this question with the Soviet Union.

Clearly, from the public Soviet statements, they agree with the former interpretation which the United States had articulated up to October 6, 1985.

Finally, as far as I am concerned, there will be no agreement on offensive systems unless and until the United States and the Soviets agree on the tight reading of article V which I am certain was agreed upon in 1972 and then focus on the key issue which is very difficult. That is, finding the dividing line between research and development in conjunction with defining what is a component.

There was discussion and there is in the record of this committee in 1972 discussion of the dividing line between research and development. But we never did get into a discussion of what a component meant or more technically what a device which substituted for a component meant in the context of article V.

That is a genuinely difficult issue. It deals with the question of dual technology for weapon systems in addition to technology that can be used for other purposes. It would be a hard one to handle. That is what the focus has to be.

Finally, I would suggest that the funds which have been voted by the Congress over these years have been made with the explicit understanding in terms of what the interpretation of the treaty was.

I would hope in the next year that the Congress would tie the spending of the funds to the standards which were articulated in the fiscal year 1985 Arms Control Impact Statement which are identical to the ones, I think, 2 years before that. I think that would hold the line.

I think it would also lead to a much more constructive potential relationship with the Soviets in terms of negotiations which will be going on in Geneva.

Thank you.

[The outline of statement and prepared statement of John Rhinelander and other attachments follow:]

OUTLINE OF STATEMENT OF
JOHN B. RHINELANDER
BEFORE
SENATE SUBCOMMITTEE ON STRATEGIC AND THEATRE NUCLEAR FORCES
NOVEMBER 21, 1985
"EXOTIC" SYSTEMS AND THE ABM TREATY

Introduction (pp. 1-5)

1. I have not had access to classified SALT I documents since 1972. Statement based on my recollections, open literature and discussions with former SALT I colleagues now out of government.

2. ABM Treaty is clear - bans development, testing and deployment of space-based "exotics" (e.g., directed and kinetic energy).

3. Soviets have taken no actions and made no statements inconsistent with this interpretation, and recently explicitly agreed.

4. My hopes for Summit had been: (a) extension of "no undercut" policy; (b) agreement to reaffirm, clarify and strengthen ABM Treaty; (c) agreement in principle to 50% cuts; and (d) another Summit in 1986. Objectives unlikely in light of Weinberger letter of November 13.

Part I (pp. 5-13)

1. OSD rationale for "reinterpretation" of ABM Treaty is Soviets never agreed and cannot now be bound.

2. "Reinterpretation" excludes "exotics" from constraints of all Articles, not just Article V(1).

3. SDI would have run up against ABM Treaty under historic interpretation between 1988 and 1991.

Part II (pp. 13-15)

1. Soviet initial draft of ABM Treaty of March 1971 in effect was permissive with both "traditional" and "exotic" technology.

2. My drafts for US delegation in May-June 1971 raised "exotics" question for inter-agency review and Presidential decision.

Part III (pp. 15-18)

1. While US delegation was split in June-July 1971, President decided: (1) permit development and testing, but not deployment, of fixed land-based "exotics", and (2) ban on development, testing and deployment of space and other mobile-mode "exotics". JCS wanted to keep option open to develop and test land-based lasers.

2. After initially balking, Soviets agreed to ban on space-based "exotics" by September 1971.

3. Major sticking point with Soviets was then contraints on fixed land-based "exotics".

Part IV (pp. 18-20)

1. All key ABM Treaty terms relating to "exotics" were agreed upon at sixth negotiating session (November

1971-February 1972), including: (a) "currently consisting of" in Article II(1), (b) "except that" in Article III, and (c) ban on deployment of nationwide defense and base for such a defense in Article I(2).

2. ABM Treaty on its face clearly banned space-based "exotics", but permitted development and testing of fixed land-based "exotics" at ABM test ranges.

3. US sought Agreed Statement D to reinforce deployment ban on fixed land-based "exotics" in Articles I(2) and III. Soviets agreed to it.

Part V (pp. 20-21)

1. I prepared detailed memoranda (Top Secret), which were shared within US delegation, on ABM Treaty and Interim Offensive Agreement during seventh and last negotiating session. No one from State, ACDA, JCS or OSD disagreed with my advice on scope of Treaty.

2. US never sought Agreed Statement on space-based "exotics", probably because unnecessary and attempt would not have been productive.

Part VI (pp. 22-24)

1. US did not insist on precision at SALT I of kind achieved at SALT II in 98 Agreed Statements and Common Understandings. Soviets stoutly resisted detailed language at SALT I.

2. Soviets agreed that "adjuncts" not constrained.

3. Research not constrained by ABM Treaty. Dividing line between research and develop, but not component versus subcomponent with respect to "exotics", was discussed with Soviets.

Part VII (p. 24-27)

1. Armed Services hearings in 1972 include: (a) submission by Ambassador Smith on distinction between research and develop in response to question from Senator Jackson; (b) submission by Secretary Laird that space-based "exotics" were banned, but development and testing of fixed land-based "exotics" were permitted, in response to question from Senator Goldwater; (c) responses by General Palmer to Senator Jackson making same points; and (d) responses by Under Secretary for DDR&E Foster on "adjuncts", and fixed land-based and space-based "exotics", in response to questions by Senator Smith and Senator Jackson [Exhibit D].

2. Senator Jackson clearly understood distinctions relating to "exotics" and voted in favor of ABM Treaty. Senator Buckley opposed Treaty largely because of ban on space-based "exotics". Treaty vote was 88-2.

Part VIII pp. 27-31)

1. In 1972-73, I wrote chapter in book which has been standard public reference on interpretation of ABM Treaty and other SALT I agreements [Exhibit E].

2. My recent SIPRI paper analyzes US and Soviet BMD programs, dicusses compliance issues and includes recommendations [Exhibit F].

3. FY85 ACIS correctly interprets treaty ban on space-based "exotics".

Part IX (pp. 32-36)

1. Soviet ratification statement in September 1972 on Article V supports ban on space-based "exotics".

2. Subsequent Soviet statements implicitly support this interpretation. Gorbachev interview with TIME is clear. Marshall Akhromeyev statement of October 19 is unambiguous, authoritative and suggests distinction between research and develop [Exhibit G].

3. Under US law, subsequent practice is at least as important in interpretation of treaties as negotiating history.

4. If Administration questioned whether Soviets agreed to ban on space-based "exotics", US should have requested agreement in writing in Geneva negotiations or in SCC.

5. Rejection of explicit Soviet position as too late makes clear OSD motive is to destroy ABM Treaty.

Part X (pp. 37-41)

1. US should strengthen ABM Treaty by specific, mutual and verifiable Agreed Statements and Common Understandings. Six former Secretaries of Defense have endorsed importance of Treaty and need to strengthen it [Exhibit H]. A booklet I

co-authored this spring includes recommended approaches [Exhibit I].

2. Three Agreed Statements on "exotics" relating to entire Treaty and particularly Article V(1) are proposed.

3. Three Agreed Statements to replace Agreed Statement D are proposed, as is another on "adjuncts".

4. This sorry practice of the unilateral US "reinterpretation" could lead to a constructive ending if Agreed Statements on "exotics" were accepted at or after the Summit as first steps to avoid further erosion of the ABM Treaty.

STATEMENT
OF
JOHN B. RHINELANDER
BEFORE
THE SUBCOMMITTEE ON STRATEGIC AND THEATRE NUCLEAR FORCES
OF
THE SENATE COMMITTEE ON ARMED SERVICES
NOVEMBER 21, 1985
ON
"EXOTIC SYSTEMS" AND THE ABM TREATY

Mr. Chairman and Members of the Subcommittee:

My name is John B. Rhinelander. I am currently a partner in the law firm of Shaw, Pittman, Potts & Trowbridge in Washington, D.C. I am also a member of the Board of Directors of the Arms Control Association, a member of the National Advisory Board of the Lawyers Alliance for Nuclear Arms Control, and a member of the ABA's Standing Committee on Law and National Security. For the past three years I have offered a seminar on Nuclear Weapons and Arms Control at the University of Virginia Law School, from which I graduated in 1961.

I served as a law clerk to Justice John Marshall Harlan after law school and subsequently in the Departments of Defense, Commerce, State, HEW and HUD. From 1971-72 I served as the legal adviser to the SALT I delegation.

I appear today in my individual capacity. My views do not necessarily represent those of any of the organizations with which I am presently affiliated. My statement represents my best recollection, after discussions with former colleagues on the SALT I delegation who are now out of government and a review of some of the available literature, on the evolution of the ABM Treaty in 1971-72 and its meaning. The SALT I negotiating record is massive and classified. I have not had access to it since 1972 and have never seen the official ACDA history of SALT I which is also classified.

The primary issue before the Committee today is whether Article V(1) of the ABM Treaty prohibits the development and testing of space-based and other mobile-type "exotic systems" (e.g., space-based lasers). The secondary issue is whether any of the Treaty's substantive constraints on "ABM systems or components" in Articles I(2), IV, V and IX apply to "exotic systems". The answers are four-fold:

(1) the prohibitions are clear from the text of the Treaty, particularly Article II(1), which clearly states the Treaty is not limited to "traditional" or then "current" technology, and Article V(1) which states, "Each Party undertakes not to develop, test or deploy ABM systems or components which are sea-based, air-based, space-based or mobile land-based";

(2) the negotiating history, as interpreted in 1972 by the SALT I delegation and the backstopping representatives in Washington, supports the broad ban on space-based "exotic systems" as the only permissible interpretation;

(3) this has been the interpretation of the Executive, accepted and relied upon by Congress, since 1972, and by the Reagan Administration in successive arms control impact statements and its recent SDI ~~Report~~ of April 1985; and

(4) any other result is patently absurd and would frustrate the stated premise of this Treaty of indefinite duration -- to prohibit the deployment of nationwide ABM systems or a "base" for such a system.

The Soviets accepted this interpretation during the negotiations and reflected it in their ratification proceedings. They have not taken any actions and have not made any official statements inconsistent with this interpretation. This is the only conclusion one can draw from their public statements which frequenty have dealt with the issue implicitly and elliptically rather than explicitly. The Gorbachev interview with TIME editors in late August of this year includes a specific statement which is clear and unambiguous, but without mentioning Article V. The TASS statement of October 9, responding to the US "reinterpretation", removed any latent ambiguity from the current Soviet public position. Marshall Akhromeyev's lengthy article on October 19, 1985 represents a definitive Soviet public affirmation of the broad ban in Article V.

The current US delegation in Geneva, and Members of Congress who are advisors, should know whether the Soviets made their position explicit, and specifically tied to Article V(1), at the Geneva negotiations or in the Standing Consultative Commission (SCC) since 1972, since the President's Star Wars speech in March 1983, and since October 6, 1985. General Secretary Gorbachev is certain to make the Soviet position clear to the President at the Summit on November 19-20.

This statement was prepared immediately before the Summit. We will know when the hearings are held whether any progress was made on arms control. In my judgment, the minimum steps which might have been expected a few weeks ago included:

(1) an extension of the "no undercut" policy with respect to the Interim Offensive Agreement of 1972 (which expired in 1977) and the SALT II Treaty of 1979 (which was never ratified but would have expired on December 31, 1985), while agreeing that the negotiators in Geneva or the SCC will focus on the compliance issues including "new types" and "encryption";

(2) a political reaffirmation of the ABM Treaty, coupled with a written agreement binding both sides to the historic position that Article V bans development, testing and deployment of space-based "exotics", while agreeing that the negotiators in Geneva or the SCC will focus on strengthening the Treaty including verifiable dividing lines between research/development and component/subcomponent, and compliance issues including large phased-array radars;

(3) an agreement to seek 50% reductions on offensive strategic systems, and related reductions on intermediate range systems, with instructions to the negotiators in Geneva to seek

the common grounds between the current US and Soviet positions; and

(4) an agreement for another Summit next summer or fall with a view to reaching the broad outlines of Vladivostok-type agreements relating to offensive and defensive systems.

The President has received divided counsel on these central issues, with Secretary Weinberger vigorously opposing in his letter to the President of November 13 steps (1) and (2), which may be preconditions for steps (3) and (4). If, however, agreement along these lines were reached, the President could be on the threshold of the most significant arms reductions since the SALT process started in 1967. If these minimum steps are not agreed upon, then Congress and our Allies may be deeply troubled by the opportunity foregone and implications for the future.

One of the recent events which makes achievement of even these modest steps doubtful is the "reinterpretation" of the ABM Treaty by the Administration.

I.

Based on National Security Advisor McFarlane's comments October 6 on NBC's Meet the Press, subsequent commentary on CBS, the article in the Washington Post on October 9 (attached as Exhibit A) and my telephone conversation that day with Deputy Secretary Taft at the Pentagon, the Administration had concluded that the Soviets never agreed to the US position at

SALT I on the scope of Article V (or the Treaty as a whole), the Soviets cannot be held to abide to it today and, therefore, the US is not legally bound. Deputy Secretary Taft told me that the General Counsel of DOD, the Legal Adviser at State, and the Department of Justice had, therefore, concluded that because the US cannot legally hold the Soviets to the historic US interpretation, the US may take the position that the development and testing of sea-based, air-based, space-based and mobile land-based "exotic systems and components" may be developed and tested, but not deployed, consistent with the ABM Treaty.

On October 11, the President decided that he agreed "in principle, but not in practice" with this "reinterpretation". Based on a Presidential directive, Secretary Shultz announced on October 14 in a speech before the thirty-first annual meeting of the North Atlantic Assembly that "a broader interpretation of our authority is fully justified", but SDI "will be conducted in accordance with a restrictive interpretation of the treaty's obligations."

This leaves the US legally free to return to the "reinterpretation" whenever the President's advisors deem advantageous and the President agrees. The stories on October 17 and 22 in the Washington Post, and Secretary Weinberger's letter of November 13 to the President which was leaked to and printed in The New York Times on November 16 (see Exhibit B), make this clear. DOD officials do not admit that they have yet lost the argument. The President has not said how long the Administration would continue to abide by the "restrictive interpretation", which now represents presidential policy rather than a matter of law.

The legal rationale for the "reinterpretation" revolves around Agreed Statement D. The Administration's argument is (1) that the Treaty, and particularly Article V(1), constrain only "traditional" ABM technology (ABM interceptor missiles, ABM launchers and ABM radars), and (2) therefore the Treaty permits development, testing and deployment of "exotic systems and components", but (3) Agreed Statement D implicitly amends Article V(1), and perhaps Article III also, to prohibit deployment only of "exotic" systems and components whatever their basing mode.

This rationale is absurd as a matter of policy, intent and interpretation. If the President sticks with it at the Summit as the best legal interpretation of the Treaty, then the President has effectively repudiated the ABM Treaty as a legal instrument. If the truncated Treaty remains in effect, then both the US and Soviets can develop and test, without quantitative or geographic limits, any sea-based, air-based, space-based or mobile land-based ABM system or component provided they utilize "exotic" technology such as lasers.

But the result could be even more far reaching and will certainly thwart any agreement on reductions of offensive systems. Because the Administration's new interpretation is that Article V(1) and other Articles of the Treaty do not apply to "exotic systems" and Agreed Statement D blocks only their deployment, then the necessary consequences are that the limits on "ABM systems or components" throughout the Treaty do not include "exotic" systems. This results in:

(1) the deployment bans on a nation-wide ABM defense, a base for such a defense, and a regional ABM defense (except as permitted by Article III) in Article I(2), which were fundamental statements of the Treaty's scope, are all limited to "traditional" ABM technology, (i.e., ABM launchers, ABM missiles and ABM radars) and do not apply to "exotic systems";

(2) the words "currently consisting of" in Article II(1), specifically inserted to make clear that the Treaty applied to all ABM technologies and not just "traditional" ones, are rendered devoid of their intended meaning;

(3) the geographic, quantitative and implicit qualitative limits in Article IV on ABM tests do not apply to tests of any type of mobile or space-based "exotic systems" because Article IV dealing with ABM test ranges explicitly refers back to Article III (which authorizes limited deployments of fixed, land-based ABM launchers, ABM missiles and ABM radars);

(4) Article V does not limit any or almost any SDI programs, and the Homing Overlay Experiment (HOE) (which was a kinetic energy test with a single intercept mechanism) could have been tested in a MIRVed configuration; and

(5) the prohibitions in Article IX (and related Agreed Statement G) against transfers of ABM systems or their components to other States, and deployment outside national territories, apply only to "traditional" technology and not to "exotic systems".

The consequences of this "reinterpretation" are dramatic when one considers that the principal US concern has historically been, and apparently remains within OSD, with Soviet "breakout" capability based on "traditional" or "low tech" systems. These remain tightly constrained notwithstanding the "reinterpretation". On the other hand, most of SDI or "high tech" systems are now "legally" unconstrained by the Treaty.

With particular respect to the Soviets and their emphasis on "traditional" systems: (a) ABM deployment is limited to the one area surrounding Moscow; (b) ABM tests must be limited to their two ABM test ranges; (c) the development, testing and deployment of land-mobile "traditional" ABM systems and components is prohibited; and (d) the ban on the "upgrade" of surface-to-air (SAM) systems remains in full force. However, under the "reinterpretation" the Soviets now legally could place in the field an unlimited number of mobile land-based lasers (the Soviets have an active laser program) for BMD purposes across the Soviet Union provided they were labeled for "test" purposes.

With particular respect to the US, it is now free to exploit its own, and Western technology, in the full pursuit of Star Wars. A full-scale, operational system, including as many as 100 to 400 killer satellites and related sensors (and presumably with fixed ground-based lasers not limited to ABM test ranges), could now be "legally" put in place as an extensive "test program" to prove out the new technology in a BMD system configuration. US allies would be free of any Treaty restraints to participate in two-way transfers of most SDI technology, with the only "legal" constraints on "west-west" SDI technology those under the Munitions Control and Export Administration Acts.

This result is absurd. Unbeknownst to the US SALT I delegation, the SALT I backstopping apparatus in Washington, the Nixon Administration and each of its successors, and Congress, the US would now be in the most one-sided Treaty relationship imaginable. Ambassador Smith should be given a retrospective decoration by the Reagan Administration for one of the great feats in American diplomatic history!

Of course, it could not last for a minute. Arms control agreements are viable only as long as they are in the net interests of each party. Secretary Shultz had spoken of the need to "prevent the erosion of the ABM Treaty", but Defense Secretary Weinberger, Under Secretary Ikle, and Assistant Secretary Perle have repeatedly stated that they have no use for the ABM Treaty and the sooner the US is without it the better. They momentarily prevailed in a brazen exercise well described in a New York Times editorial by Anthony Lewis (see Exhibit C). Secretary Weinberger's letter to the President, leaked to the press on the eve of the Summit, reinforces this view that treaty commitments which impinge US programs are of little relevance to OSD. Unless the US and Soviets agree at the Summit on specific Agreed Statements to put the "reinterpretation" to rest, or the President or Congress repudiate this self-defeating step, OSD officials could move the issue again when the moment seems right to them.

The timing of the announcement of the initial "reinterpretation" remains obscure. DOD has known, of course, that under the historic interpretation the evolution of SDI research into development and testing would have to be stopped somewhere between 1988 (as I believe and have written and testified) and 1991 (as even DOD officials had privately conceded) unless either the Soviets agree to amend the Treaty or the US formally withdraws. From a policy and political point of view, six weeks before the Summit, the "reinterpretation" by the US with respect to a legally binding treaty could have been a disaster, but the President could still rectify it. The first concrete US response to the Soviet pre-Summit proposal to cut offensive forces by 50% (admittedly lopsided and a repudiation of the Vladivostok Accord) was to repudiate the ABM Treaty which, both had agreed last January, is interrelated to any offensive limitations.

One of the political reasons for the Administration's initial "reinterpretation" at this time may have been OSD's attempt to redefine the Treaty before the President leaves office in January 1989 even though no presently scheduled test could, in OSD's judgment, be inconsistent with the Treaty by that date. Another reason may have been to encourage more Allies to support SDI by participating in cooperative SDI "research". (The negotations with the UK on a government-to-government agreement may be completed shortly and an agreement with the FRG thereafter). Foreign corporations, particularly in the United Kingdom and West Germany, might be encouraged by the "reinterpretation" because cooperation might "legally" be extended from ABM "research", which is all that is permitted under the historic US interpretation, to include now "development and testing" with full sharing and two-way transfers.

The actual effect on US Allies was the reverse because the political fallout of this full sharing in SDI technology directly associated with ABM systems or components would have been the implicit or explicit ratification by Allied governments of the repudiation of the ABM Treaty. That is a role that none is prepared to accept or condone, including the United Kingdom. Margaret Thatcher earlier had achieved at Camp David the President's agreement to four basic principles relating to SDI. The political cost in West Germany and the Netherlands might have been much higher for their governments and NATO as a whole. The Soviets have sharply criticized West German participation in cooperative research which, I have previously testified, is permitted under the Treaty.

The remainder of my statement sets forth my views on the negotiation and meaning of the ABM Treaty, and steps to reverse this damaging and probably unprecedented US treaty practice of unilateral reinterpretation of a central provision.

II.

In April 1971, while I was serving in Washington as a Deputy Legal Adviser at the Department of State, Ambassador Gerard Smith asked me to come to the fourth negotiating session of SALT I in Vienna and prepare drafts of an ABM Treaty and an Interim Offensive Agreement. In March 1971, the Soviet delegation had tabled a draft ABM Treaty. The US delegation believed it was appropriate to begin to prepare formal texts of agreements on defensive and offensive strategic weapons limitations. I spent most of that session reviewing the record of the negotiations (plenary statements, memoranda of conversations, reporting cables, etc.), familiarizing myself with US position papers and the technical characteristics of the weapons, and in discussions with members of the US delegation. I also prepared rough first drafts of texts. The negotiating session ended in May 1971, shortly after the "May 20 understanding" between the US and Soviets was announced.

During the remainder of May and in June in Washington, I prepared successive drafts of an ABM Treaty and an Interim Offensive Agreement with continuing input from others. I recollect that the Soviet draft of Article III of their ABM Treaty was permissive - it stated both sides may deploy a single, fixed land-based ABM system with 100 ABM launchers, but it contained no limits on the numbers, or qualitative characteristics, of ABM radars within the ABM deployment areas. This text was vague, imprecise and, among other things, an invitation to pursue and deploy both stand-alone ABM-capable components, such as long lead-time radars, and also ABM systems based on "exotic" technologies. In my drafts, I turned Article III around into the form eventually agreed upon and also tightened it.

Article III, as redrafted, prohibited deployment of any ABM system or components except those in the deployment areas and as limited quantitatively, qualitatively and geographically. The text of Article III, standing alone, prohibited the deployment of fixed land-based "exotic" ABM systems and components because only systems utilizing ABM launchers, ABM interceptor missiles and ABM radars could be deployed. This raised the "exotic systems" question directly for inter-agency consideration and Presidential decision.

The substantive Articles always referred to "ABM systems" and to "components" to make clear the US position that components were limited and not just entire systems.

The Soviet draft of March 1971 contained prohibitions on testing and deployment of "space-based" systems in what is now Article V(1), as did my drafts of May-June 1971 which, I believe, added "develop". The gist of this paragraph in Article V was derived from the August 4, 1970 proposal by the US for bans on production, testing and deployment of all mobile-type ABM systems and components.

My drafts of May-June 1971 were reviewed by members of the SALT delegation while in Washington and hand carried to Helsinki. Some of the delegates had sharply differing views on "exotic systems" and other questions.

III.

The fifth negotiating session began in Helsinki in early July 1971. After taking into account the President's written instructions, the delegation revised my drafts, cabled texts of an ABM Treaty and an Interim Agreement to Washington, and sought authorization to table them in a plenary session. On the "exotic systems" questions, the delegation was split. Gerard Smith wrote in Doubletalk: The Story of SALT I (Doubleday, 1980), that he and Harold Brown supported a broad ban; Paul Nitze concurred except for sensors; but General Allison and Ambassador Parsons favored no restraints at all on "exotic systems" (pp. 263-65).

The delegation was subsequently authorized to table the text of both agreements, which it did on July 27, but with the article in the ABM Treaty covering space-based systems omitted. The Verification Panel in Washington was still analyzing the "exotic systems" question. Eventually, the President rejected the ABM ban which Ambassador Smith had privately urged, but about the same time the President approved a White House staff compromise to the basic Smith-Brown position on "exotic systems" which would prohibit: (1) the deployment of fixed land-based systems and components and (2) the development, testing and deployment of systems and components for all other basing modes. The Joint Chiefs of Staffs were particularly interested in preserving the option to develop and test fixed-land-based lasers. The President's decision maintained this option, as does the ABM Treaty itself. See John Newhouse, Cold Dawn: The Story of SALT (Holt, Reinhart, and Winston, 1973), pp. 230-31, 237; Raymond L. Garthoff, Detente and Confrontation: American-Soviet Relations from Nixon to Reagan (Brookings Institution, 1985), ch. 5.

The US delegation filled in the blank Article in its ABM Treaty in mid-August 1971. The Soviets initially balked at discussing, let alone agreeing to any limitations on, "exotic systems". They were probably without any instructions on this issue and may have felt the US was on an intelligence-fishing expedition. Progress was soon made nevertheless. Various working groups and a drafting group were set up to seek agreement issue by issue. Joint Draft Texts of the Soviet and US drafts of the Treaty were prepared with disagreed language, which at first was extensive, in brackets.

The Graybeal-Karpov Working Group focused on Article V. (Sid Graybeal was later the US Commissioner to the Standing Consultative Commission. Victor Karpov is currently the head of the Soviet delegation in Geneva.) Before the conclusion of the fifth negotiating session in September 1971, the Graybeal-Karpov working group agreed, ad referendum to the two delegations, that current Article V(1) covered "current" as well as "exotic" technologies. The US delegates agreed that the Americans on this working group (which included Albert Carnesale, now at the Kennedy School at Harvard) had carried out the President's instructions. The brackets around "develop" in that paragraph in Article V in the Joint Draft Text were subsequently removed in the drafting group during the sixth negotiating session after both delegations had noted their approval. The Administration now contends that either the Soviets never agreed with the US interpretation or that the Soviets later modified their agreement or changed their interpretation during negotiations over Agreed Statement D. The US members on this Working Group would sharply differ with this view.

The major sticking point then, and through late into the sixth negotiating session, was on fixed land-based systems. US instructions were to preserve the right to develop and test, but not to deploy, fixed land-based lasers. Accordingly, the US delegation insisted that Article III should authorize deployment of only ABM systems and components which are based on "current" technology. Further, development and testing, whatever the technology, of fixed land-based systems and components could be carried out only at ABM test ranges. The Soviets resisted any limitations on fixed land-based "exotic systems". As John Newhouse, who many believe was given at least some access to NSC files, wrote (Cold Dawn, p. 237):

> Back in the summer, Moscow's attitude, as reflected by its delegation, had been sympathetic. Then, in the autumn, it hardened, probably under pressure from the military bureaucracy. Washington was accused of injecting an entirely new issue. Moscow would not agree to a ban on future defensive systems, except for those that might be space-based, sea-based, air-based, or mobile land-based. The U.S. delegation persisted and was rewarded. Land-based exotics would also be banned. The front channel had produced an achievement of incalculable value.

IV.

The Article III issue was not resolved until the sixth (Vienna in November 1971 - February 1972) negotiating session. It was handled principally in the Garthoff and Kishilov or Grinevsky working group and also in the Garthoff/Parsons-Kishilov/Grinevsky group. (Ray Garthoff and Nicolai Kishilov were the executive secretaries of the respective delegations.)

The US proposed the "currently consisting of" phrase which was agreed upon for Article II(1) to make clear that references to ABM systems or components in the Treaty were not limited to "traditional" technology. The US proposal for the "except that" formulation for Article III was accepted which made clear that only fixed land-based "traditional" systems could be deployed. The ban against a nationwide defense and "base" for such a defense in Article I(2), which was a Soviet initiative intended in part to deal with "exotic systems", was agreed. In each case, agreement was ad referendum to the delegations. Together, these textual provisions completed all the key words in the Treaty relating to "exotic systems".

An agreed interpretation tied to Articles I and III was first proposed by Garthoff in mid-December 1971. I distinctly recollect advising that no supplementary interpretation was technically necessary with respect to fixed land-based "exotics". The US effort, therefore, was to reinforce the clear meaning of the specific Article III and the more general Article I(2).

The US had originally proposed a third paragraph for the current Article V of the Treaty in August 1971. It stated: "Each party undertakes not to deploy ABM systems using devices other than ABM interceptor missiles, ABM launchers or ABM radars to perform the functions of these components". Doubletalk, pp. 265, 343-44. The Soviets balked at any Treaty language specifying "exotics" and, subsequently, at the initial US proposals for an agreed interpretation. Eventually the Soviets proposed a counter draft. This was modified several times at US insistence (including the insertion of the opening phrase "In order to insure fulfillment of the obligation not to deploy ABM systems and their components except as provided in Article III of the Treaty . . ."). (Emhasis added.) The reference to Article XIV in Agreed Statement D indicated that the Treaty would have to be amended before a fixed land-based "exotic", such as a laser, could be deployed. The final compromise language for Agreed Statement D was proposed by Garthoff to the Soviets in late January 1972 and early in February Kishilov informed Garthoff of Soviet agreement. This was eventually noted in an US plenary statement. Agreed Statement D and the other Agreed Statements were initialed on May 26, 1972 by Ambassadors Smith and Semenov.

Agreed Statement D refers to, and interprets, Article III only. although the references to "other physical principles" and "components capable of substituting for" are equally aplicable to Article V(1). While the language admittedly could be clearer, the US has always understood that Agreed Statement D reinforced the Articles I(2) and III prohibition on deployment of fixed land-based "exotic systems" unless and until the Treaty is amended. Finally, and most importantly, Agreed Statement D certainly does not diminish or amend Article V(1) and the other substantive Articles such as I(2), IV, V(2) and IX.

V.

During the seventh negotiating session, I prepared detailed memoranda, classified Top Secret, on both the ABM Treaty and the Interim Agreement intended to serve four distinct purposes: (1) inform the delegation on what was agreed with the Soviets and what was not; (2) suggest whether the US should consider seeking one or more Agreed Statements to provide more specific interpretations; (3) indicate what types of weapons programs, current and future, were prohibited and permitted; and (4) serve as the basis for the eventual transmittal documents to Congress and background for the Congressional hearings.

Successive drafts of my memoranda were shared within the US delegation. When there was any doubt that a matter was agreed, the proposition was enclosed in brackets. The brackets were removed only after I, and others on the US delegation, were satisfied. I constantly revised the drafts as issues were reviewed. The draft memoranda were never made "final".

In certain cases the US delegation sought and achieved Agreed Statements. In others it did not seek them. Some matters were judged agreed, while others were not. To the best of my recollection, the US delegation never sought an Agreed Statement confirming that Article V(1) covered "exotic systems". We probably felt that seeking further specific agreement was unnecessary and would not be productive. In any event, I am absolutely certain that my contemporaneous advice to the US delegation on the scope of Articles III and V(1) with respect to "exotic" systems as reflected in my draft memoranda was clear and that none of the delegates nor their advisors (State, ACDA, JCS and OSD) disagreed with that advice. I recall no indication that the Soviets thought otherwise.

VI.

During SALT I the US delegation, and the backstopping team in Washington, did not insist on the kind of precision reached in the SALT II Treaty with its 98 Agreed Statements and Common Understandings. The Soviets stubbornly resisted the level of textual detail in both the ABM Treaty and the Interim Offensive Agreement that the US had initially sought at SALT I. Neither the President nor Henry Kissinger cared much for detail. During the final three negotiating sessions, the US delegation made _ad hoc_ decisions on how the Presidential instructions should be sought and recorded on many issues, how hard to push for additional clarity and what sufficed, but constantly reported to Washington.

In one instance relating to the ABM Treaty, the US proposed and the Soviets accepted that an "adjunct", which supplemented and did not substitute for, a permitted ABM component was not constrained in any way. The example the US gave was a telescope used in conjunction with a fixed land-based ABM radar. I do not recall whether this issue, important to DOD, was covered in any formal statement.

In another instance relating to the ABM Treaty ("current" Soviet ABM test ranges), the US delegation identified the two US ABM test ranges and the Soviet test range at Sary Shagan. The Soviet response noted national technical means permitted the identification of test ranges. (The US and Soviet statements are set forth in Common Understanding B.) The US delegation noted immediately that the Soviets did not respond to the US identification of Sary Shagan as their ABM test range, but the delegation believed the Soviet finesse reflected extreme Soviet sensitivity to any discussion of their test range. However, in the mid-1970s the Soviets claimed a second "current" ABM test range at Kamchatka based on the presence of an old radar. (Paul Nitze has referred to this negotiating technique as unworthy of bazaar traders. I agree, although the US could have gone back to the Soviets again.) The US eventually accepted the Soviet claim in 1978 because there was a factual basis for it, but learned from this example, and particularly from the Moscow Summit negotiations on the Interim Offensive Agreement, that explicit agreement and written precision is important. The SALT II documentation reflects this learning.

SALT I, however, did not have this benefit of later-day hindsight indicating the need for precision and detailed Agreed Statements and Common Understandings reflected in the SALT II Treaty. Some of the SALT I underlying understandings are reflected in formal plenary statements, others in the less formal mini-plenary statements, and some in working documents, memoranda of conversations ("memcons") and reporting cables. Agreement was reached *ad referendum* in one or more working groups, approved by the two delegations, referred to the drafting group, to the interpreters, etc. On many points there will not be simple, clear documentation. In addition, the US government (but not the Soviets) has lost most of its SALT I historical memory.

Some interpretation matters were in 1972, and remain today, ambiguous and need clarification. The dividing line between permitted "research" and prohibited "develop", and the related meaning of "component", is not clear in the broad prohibitory context of banning "exotic systems" under Article V(1). There is no Agreed Statement on either issue. The former was discussed in a formal statement delivered by Harold Brown and a general understanding, although not a fully documented record, was reached. I do not recall any discussion of the latter with the Soviets.

VII.

The SALT delegation remained in Helsinki until agreement on open points, primarily the Interim Offensive Agreement, was reached at the Moscow Summit. When the delegation returned to Washington and the transmittal documents and Congressional statements were being prepared under White House control, Henry Kissinger directed that all "understandings" be culled from the negotiating record and made public to refute criticism of secret agreements. This was the derivation of the SALT I Common Understandings. The search of the files for Common Understandings was limited. It did not cover all the myriad of agreed understandings reflected in the texts themselves or reached in less formal ways during the negotiations.

The hearings before the Senate Foreign Relations Committee, and particularly the Senate Armed Services Committee, led to a much fuller public record on many of the nuances. Some of the initial testimony of officials on "exotic" systems was not clear in emphasizing fixed land-based and slighting space and other mobile-type systems, but the record was frequently supplemented. This includes the submission for the record of the Senate Armed Services Committee by Ambassador Smith, prepared after inter-agency review of reporting cables, in response to a question by Senator Jackson on the difference between research and development for purposes of Article V. Military Implications of the Treaty on Limitations of Anti-Ballistic Missile Systems and the Interim Agreement on Limitation of Strategic Offensive Arms, Hearing before the Committee on Armed Services, United States Senate, 92nd Cong., 2nd Sess., p. 377. This issue was important, of course, to the understanding that Article V applied to "exotic" systems.

The Armed Services Committee hearings include explicit confirmations submitted by Secretary of Defense Melvin Laird, Under Secretary for DDR&E John Foster, and Acting Chief of Staff of the Army General Palmer that development and testing, as well as deployment, of space-based "exotic systems" were prohibited.

In response to a written question from Senator Goldwater, Secretary Laird submitted a response which stated (Armed Services Hearings, pp. 40-41):

> Answer: With reference to development of a boost-phase intercept capability or lasers, there is no specific provision in the ABM Treaty which prohibits development of such systems.
>
> There is, however, a prohibition on the development, testing, or deployment of ABM systems which are space-based, as well as sea-based, air-based or mobile land-based. The U.S. side understands this prohibition not to apply to basic and advanced research and exploratory development of technology which could be associated with such systems, or their components.
>
> There are no restrictions on the development of lasers for fixed, land-based ABM systems. The sides have agreed, however, that deployment of such systems which would be capable of substituting for current ABM components, that is, ABM launchers, ABM interceptor missiles, and ABM radars, shall be subject to discussion in accordance with article XIII (Standing Consultative Commission) and agreement in accordance with article XIV (amendments to the treaty).

The exchanges between Senator Jackson and John Foster are particularly important because they note the important "adjunct" concept, confirm Article V(1) applied to "exotic" space-based systems and stated the US understanding of the distinction between research and develop (see Exhibit D).

Senator Jackson (D, Wash.), who was a sharp critic of SALT I but voted in favor of the ABM Treaty, understood the scope of Article V clearly (see Exhibit D). He was probably the most knowledgeable Senator on the impact of SALT I on weapons programs. As members of this Subcommittee know, the hearings before the Senate Armed Services Committee were instrumental in Senate consideration of SALT I and SALT II. In fact, the implications of SALT on US weapons systems were reviewed by the Armed Services Committee with DOD witnesses who could speak with authority and, if necessary, submit responses for the record, some of which are classified.

Finally, Senator James Buckley (R, NY) stated on the Senate floor on August 3, 1972 that he opposed the ABM Treaty and would vote against it largely because of the scope of Article V. He said:

> Thus the agreement goes so far as to prohibit the development, test or deployment of sea, air or space based ballistic missile defense systems. This clause, in article V of the ABM treaty, would have the effect, for example, of prohibiting the development and testing of a laser type system based in space which could at least in principle provide an extremely reliable and effective system of defenses against ballistic missiles. The technological possibility has been formally excluded by this agreement.

The vote in favor of advice and consent to ratification was 88-2.

VIII.

I resigned from government in June 1972 after the transmittal documents had been sent to Congress and before the hearings. While I later served at HEW as General Counsel and at HUD as Under Secretary between 1973 and 1977, I have had no official role in the SALT process since June 1972. I left behind at ACDA two complete file cabinets of all my working papers which I have not seen since 1972, including my memoranda analyzing the ABM Treaty. I understand my records were later sent to a warehouse by ACDA and, at least as of several years ago, the files could not be located although copies of some documents, including at least the last two drafts of my memoranda analyzing the ABM Treaty, were preserved by the JCS and perhaps in some other files.

In 1972-73 while in private practice, I co-edited a book on SALT and wrote chapter 5 on "The SALT I Agreements". I have attached to this statement the pages from that chapter (Willrich and Rhinelander (editors), SALT: The Moscow Agreements and Beyond (Free Press, 1974)) on the ABM Treaty (Exhibit E). This chapter has served as the standard public reference on SALT I interpretations. Pages 128-29 and 134 are directly on point with respect to "exotic systems"and state:

> The future systems ban applies to devices which would be capable of substituting for one or more of the three basic ABM components, such as a "killer" laser or a particle accelerator. Article III of the treaty does not preclude either development or testing of fixed land-based devices which could substitute for ABM components, but does prohibit their deployment. Article V, on the other hand, prohibits development and testing, as well as deployment, of air-based, sea-based, space-based, or mobile land-based ABM systems or components, which includes "future systems" for those kinds of environments. The overall effect of the treaty, therefore, is to prohibit any deployment of future systems and to limit their development and testing to those in a fixed land-based mode. Certain devices, such as telescopes, which are simply adjuncts to, not substitutes for, present ABM components are not covered.
>
> These constraints on future ABM systems, which the U.S. proposed, are an attempt to ensure a long-term, effective limitation on strategic defensive systems in an age of changing technology. Neither laser

> technology nor any other kind of device now appears to have a significant ABM potential; for instance, a land-based laser would not be effective in the event of cloud cover, and the platform for an air-based laser would itself be a vulnerable target. However, the failure to include a broad proscription against future devices might have led to a significant effort by either or both the U.S. and U.S.S.R. to develop esoteric ABM systems. The prohibition in the treaty thus serves the same preventive purposes as the prohibition on placing weapons of mass destruction in orbit which is countained in the Outer Space Treaty of 1967.
>
> * * * *
>
> The effect of paragraph 1 of Article V is to limit ABM systems or ABM components which may be developed, tested, or deployed under Articles III and IV to those which are fixed land-based. While paragraph 1 of Article V expressly refers to sea-based, air-based, space-based, or mobile land-based ABMs, the intention was to foreclose ABM components except fixed land-based; therefore ABM components are prohibited not only from the bottom of the sea but also on or in lakes or rivers. The prohibitions in Article V apply to each of the three basic ABM components, as well as the system as a whole, and would therefore prohibit a sea-based ABM radar linked with land-based ABM launchers and interceptor missiles. It would also prohibit future ABM systems, such as an airborne killer laser, as a substitute for a fixed land-based ABM interceptor missile, or a space-based sensor that, coupled with land-based components, was capable of substituting for one or more current ABM components. There are, however, gray areas since the treaty does not limit deployment of sensors or satellites which provide early warning of missile launches.

This chapter summarizes my immediate recollection of the classified advice I had given to the US delegation and which was the basis for the Executive position before, during and after the ratification process. Prior to publication of the book, I informally cleared my chapter with government officials to ensure both accuracy and non-disclosure of sensitive information.

Over the past eight years, I have been informally queried on various issues relating to the ABM Treaty by officials at the JCS, OSD, State, ACDA and the CIA. My first response has always been to check my book chapter and then the Top Secret memoranda I had prepared while in government. One question in the late 1970s was whether there were any deployment limits on fixed land-based "exotic systems". This question had been raised in OSD and by an official at the RAND Corporation, sharply debated with JCS supporting the traditional US position, and then correctly resolved. This question also involved Agreed Statement D, but in this case the OSD argument was that there were no deployment limits under Article III on fixed land-based "exotic systems" and only an obligation to discuss. This is almost the exact reverse of the Reagan Administration's "reinterpretation" which now claims the deployment limits in Agreed Statement D prohibits only deployment of systems referred to in Articles III and V(1).

To the best of my knowledge, the challenge to Article V(1) within the Executive arose only recently although the Heritage Foundation circulated a Backgrounder dated April 4, 1985 rejecting the traditional interpretation. A footnote stated it was authored by an unnamed government arms control official. Apparently work was later done at RAND, before OSD and the Legal Adviser arrived at the "reinterpretation".

This past spring I co-authored with Tom Longstreth and John Pike a booklet on The Impact of U.S. and Soviet Ballistic

Missile Defense Programs on the ABM Treaty, National Campaign to Save the ABM Treaty (March 1985). In April, I testified before a House Foreign Affairs Subcommittee and excerpts from my formal statement were reprinted in *Arms Control Today* (May 1985). In July I presented a paper at a SIPRI conference which sets forth my analyses and recommendations. A copy of the latter, as revised in August, is attached as Exhibit F. These documents, and particularly the SIPRI paper, reflect my views on the correct interpretations of the ABM Treaty and basic issues raised by current US and Soviet BMD programs.

In my judgment, the FY85 Arms Control Impact Statement prepared by the Reagan Administration correctly states the agreement reached with the Soviets in 1971-72 on the meaning of Article V(1). It provides (pp. 251-52):

> The ABM Treaty bans the development, testing and deployment of *all* ABM systems and components that are sea-based, air-based, space-based or mobile land-based....The ABM Treaty prohibition on development, testing and deployment of space-based ABM systems, or components for such systems, *applies to directed energy technology (or any other technology used for this purpose*.) Thus, when such directed energy programs enter the field testing phase they become constrained by these ABM Treaty obligations. (Emphasis added.)

The SDI Report to Congress (April 1985), especially Appendix B, is essentially consistent with this statement.

IX.

In the Soviet parliamentary ratification deliberations, the First Deputy Minister of Foreign Affairs, Vasily V. Kuznetsov, "on behalf of the Soviet Government," gave the Presidium of the Supreme Soviet the official Soviet position on the ABM Treaty. He said that, "The sides pledge themselves not to create or develop ABM systems or components emplaced in the sea, the air or space or of a mobile ground type . . . ." He presented this as a clear obligation of the Treaty as a whole. Marshall Grechko also noted that the ABM Treaty does not limit research. (See Pravda, September 30, 1972, as translated in FBIS, Oct. 3, 1972).

Based on my review of available documents, the Soviets had not explicitly tied their interpretation of Article V(1) to "exotic systems" in public until recently although their statements implicitly supported this as the only interpretation of the entire Treaty, including Article V(1). However, General Secretary Gorbachev's written response to TIME states, "In our view, it [SDI] is the first stage of the project to develop a new ABM system prohibited under the Treaty of 1972. See TIME (Sept. 9, 1985), p. 24. (Emphasis added.) (See also Soviet documents printed in Ballistic Missile Defense Technologies (OTA, 1985) pp. 312-15.)

Specific Soviet responses to the US "reinterpretation", which was made first on television on October 6 and then repeated in the press, are contained in FBIS on October 9 and

10. They include the translation of a TASS commentary and an English-language TASS article.

Finally, Marshall Sergei Akhromeyev, the Chief of the Soviet General Staff, made lengthy comments in an article in Pravda on October 19. He said the ABM Treaty "absolutely unambigously bans" the development, testing and deployment of space-based "exotic" ABM systems. Marshall Akhromeyev explictly confirms the historic interpretation. His article, published in full by the Soviet Embassy as a paid advertisement in The Washington Post, is attached. (See Exhibit G.) This is a very important statement, particularly since it suggests a dividing line between permissible research and prohibited development and testing. The nine relevant paragraphs on the scope of the ABM Treaty provide:

> In order to justify the militarization of outer space, Washington alleges that the U.S. work on the so-called "Strategic Defense Initiative" (SDI), in fact a Star Wars program, is something quite legitimate and even allowed by the 1972 Soviet-American treaty limiting antiballistic missile defenses. A "new interpretation" of the treaty has been offered, according to which it purportedly allows the development, testing and creation of antimissile weapons systems on the the basis of "other physical principles," that is, laser, particle-beam and other types of weaponry, both land- and space-based.
>
> Thus, the President's national security advisor Robert McFarlane, when appearing on NBC television program on October 6, distorted the essence of the ABM Treaty. Trying to substantiate the "lawfulness of experiments" within the framework of the infamous Strategic Defense Initiative, he contended that the treaty supposedly sanctions tests of any ABM systems if only they are based on other principles of physics. The ABM Treaty is negated also by the so-called "new" confidential study prepared by the

Pentagon concerning limitations envisaged by the treaty. It is contended in the study that the provisions of the treaty supposedly can be applied only to radars and antimissiles but not to the development and testing of "exotic" ABM systems (lasers, beam weapons).

Such "interpretations" of the ABM Treaty, to put it mildly, are deliberate deceit. They contradict reality. Article 5 of the treaty absolutely unambiguously bans the development, testing and deployment of ABM systems or components of space or mobile ground basing, and, moreover, regardless of whether these systems are based on existing or "future" technologies.

In accordance with the agreed-upon statement "D" to the treaty, to which the Administration now refers so often, the conduct of research, development, and testing of ABM systems or their components based on other physical principles is allowed in areas that are strictly limited and defined by the treaty and only using permanent land-based ABM systems (as they are defined in Article 3 of the treaty). Moreover, if either side wants to deploy this type of new system in these limited areas, it cannot do so without preliminary consultations with the other side and without introducing the appropriate agreed-upon amendments in the treaty.

Only this and no other interpretation of the key provisions of the ABM Treaty, which was initiated in its time by the United States itself, was worked out and adopted by the two sides in the course of talks on this treaty. The present aim of the United States Administration is clear: to prepare a "legal base" for carrying out all the practical stages of work within the framework of the SDI program, that is, the development, testing and deployment of space strike systems.

The ABM Treaty is becoming an obstacle to the United States in the fulfillment of Star Wars plans. In his striving to clear the road to the militarization of outer space, Secretary of Defense Caspar Weinberger, when speaking in the National Press Club in Washington, threw aside the subterfuges of McFarlane and others and bluntly stated that the United States should study the possibility of really withdrawing from the ABM Treaty. This is the actual position of the United States.

> The Soviet Union is of a diametrically opposite opinion. The termless ABM Treaty is of fundamental importance for the entire process of nuclear arms limitation. Even more, it is the basis on which strategic stability and international security rest. We are convinced that everybody, including the United States, will stand to lose from a violation of this treaty. The USSR is strictly observing all commitments under the treaty and is not doing anything that would contradict its provisions.
>
> The Soviet stand on space strike arms was clearly formulated by Mikhail Gorbachev. It is necessary for a ban to embrace every phase of the inception of this new class of arms. This, however, does not deny the right and possibility to conduct basic research in outer space. But it is one thing to conduct research and studies in laboratory conditions and quite another thing when models and prototypes are created and samples of space arms are tested. This is always followed by deployment of arms. It is precisely such a line, backing it up accordingly with propaganda, that the United States Administration is pursuing as regards the Star Wars program. The USSR views as impermissible any out-of-laboratory work connected with the development and testing of models, pilot samples, separate assemblies and components. Everything that is being done for the subsequent designing and production of space strike systems should be banned.
>
> The Soviet Union's approach is substantiated and realistic also from the point of view that out-of-laboratory work can be verified by national technical means. If this process is cut short at the initial stage of research, the possibility of development space strike arms will vanish.

The Administration's justification for its "reinterpretation" is that the Soviets cannot be held to comply with the historic US position. Instead of reinterpretating the clear text of the 1972 Treaty based on a selective review of the classified US negotiating records, the better approach under international law and practice would have been to review post-ratification statements and conduct, which is at least as important as the negotiating record. See ALI Restatement of the Law, Foreign Relations Law of the United States (Revised), Tentative Draft No. 6 - Vol. 2 (Apr. 12, 1985), §325 (an international agreement is to be interpreted in good faith in accordance with the ordinary meaning of its terms and in light of its objects and purpose, and any subsequent practice between the parties in the application of the agreement is to be taken into account in interpretating the agreement). If any doubt remained, the best approach would have been to ask the Soviet negotiators in private in Geneva whether or not the Soviet Union agrees that Article V(1) bans the development, testing and deployment of "exotic systems" and ask whether they were prepared to be bound in writing. If the private Soviet response had been "no", then the Administration's "reinterpretation" would have been justified.

If the private Soviet response in Geneva were "yes", as one would expect from their public statements since 1972, then the October 6 "reinterpretation" and the October 11 recanting by the Administration would have been unnecessary. Agreed Statements on the basic points could have been quickly negotiated if deemed necessary for clarity.

If a private but positive Soviet response in Geneva were now rejected by the US as "too late", either by US negotiators or the President, because the US wanted to keep open the option of reasserting its "reinterpretation", then the OSD motive behind the initial change in US position - to erode immediately and eventually destroy the ABM Treaty - would be clear.

X.

As I have testified, written and spoken in various forums in the past two years, the challenge now is to strengthen the ABM Treaty through specific, mutual and verifiable Agreed Statements and Common Understandings. Six former Secretaries of Defense endorsed the importance of the Treaty and the need to strengthen it before this controversy broke (see Exhibit H).

Of course the Soviets must become responsive on the Krasnoyarsk radar which appears to be a clear violation. The recent Soviet offer to cease construction is an important step. That radar, however, should come down. Four US radars (the PAVE PAWS in Georgia and Texas, and phased-array radars for Thule and Fylingdale Moors) raise Treaty questions which are not frivolous. The SIPRI paper I gave in July analyzes the key issues raised by programs on both sides, and the booklet I co-authored this past spring contains a series of specific recommendations (see Exhibit I) which were intended to start a constructive process consistent with Secretary Shultz's stated goal of reversing the erosion of the ABM Treaty.

In conclusion, let me suggest approaches for three Agreed Statements based upon, and entirely consistent with, my recollection of the SALT I negotiating record which would clarify the overall scope of the ABM Treaty, particularly Article V(1):

(1) First Agreed Statement to Article II(1). As used in this Treaty, "ABM systems", "ABM systems or components", "ABM

systems and components" and "ABM systems or their components" include ABM interceptor missiles, ABM launchers, and ABM radars as defined in Article II(1) and any devices based on other physical principles which are capable of substituting for or performing the functions of ABM interceptor missiles, ABM launchers, or ABM radars.

(2) First Agreed Statement to Article V(1). Article V(1) applies to ABM components as defined in Article II(1), and any devices based on other physical principles which which are capable of substituting for or performing the functions of ABM components, if any of the components or devices are sea-based, air-based, space-based or mobile land-based.

(3) Second Agreed Statement to Article V(1). As used in Article V(1), "develop" refers to that stage of the research and development cycle at which field testing, observable by national technical means, is initiated on ABM components as defined in Article II(1) or on devices which are capable of substituting for or performing the functions of ABM components.

The third suggestion does not reach the key issues of defining the dividing line between research/develop and device/subcomponent. It points out the compelling need to begin the difficult process of resolving some of the ambiguities inherent in the ABM Treaty. The Standing Consultative Commission (SCC) was established with this as one of its assigned tasks.

The SCC has been under-utilized. The SCC could easily, and quickly, also review and revise Agreed Statement D to make its intended meaning clearer. A starter in replacing Agreed Statement D could be:

First Agreed Statement to Article III. Article III prohibits the deployment of fixed land-based devices based on other physical principles which are capable of substituting for or performing the functions of fixed land-based ABM systems or components as defined in Article II(1).

First Agreed Statement to Article IV. Fixed land-based devices based on other physical principles which are capable of substituting for or performing the functions of ABM components as defined in Article II(1) may be developed and tested at ABM test ranges described in Article IV.

First Agreed Statement to Article XIV(1). Any obligation in this Treaty may be discussed in accordance with Article XIII and an amendment adopted in accordance with Article XIV.

To these could be added an Agreed Statement recognizing "adjuncts", which was a concept important to DOD in 1972. A proposed text might provide:

Second Agreed Statement to Article III. An adjunct which supplements and does not substitute for a fixed land-based ABM component as defined in Article II(1) is not limited by Article III or any other Article of this Treaty.

The seven suggested Agreed Statements do not even touch on the question of distinguishing a "component", or device capable of substituting for or performing the function of a component, from a "subcomponent", assembly, adjunct, etc., or the equally difficult question of distinguishing prohibited ABM-related space-based sensors from space-based sensors for early warning or for other permitted purposes. Counting rules, presumptions, and ad hoc approaches will all be necessary. Special technical advisors (physicists, engineers, military advisors) to the Executive and to Congress may have a critical role to play. These challenges will be truly difficult even with the best of intents. The details in this and other areas will be critically important to the long-term viability of the Treaty.

Before constructive steps can start, however, and assuming the Soviets are prepared to negotiate and not just posture, the President should publicly repudiate the consequences of the legal advice he has recently received from his advisors on a narrow scope of Article V(1) and other critical Articles of the ABM Treaty. Congress could contribute to this result by approving an amendment to a DOD authorization bill limiting fund expenditures to the legal standard in the FY85 Arms Control Impact Statement. This would be a positive step next year if the issue is not closed by written agreement with the Soviets at the Summit.

This whole sorry business could lead to a constructive ending if the US and Soviets were to agree privately in Geneva, at or after the Summit, on Agreed Statements along the lines that I have suggested. These should be only the first of many steps needed to avoid further erosion of the ABM Treaty of 1972.

Senator HART. Mr. Chairman, could I ask a question?

Mr. Rhinelander, do I understand that what you said was virtually immediately after negotiations you prepared two long memoranda that summarized what went on and that those were lost?

It seems to me you said they otherwise might have been part of the record; or were they ever part of the record?

Mr. RHINELANDER. They were never part of the record. Those were kept only within the U.S. delegation. I prepared those during the seventh and last negotiating session in Helsinki.

The ABM Treaty was basically locked up. The only issue was the distance between the two systems alluded to in the 1972 treaty. The 1974 protocol knocked it down to one. The memoranda went through successive drafts as I and other members of the delegation reached firmer conclusions. I prepared them.

One of the reasons was to inform DOD about the kinds of weapons permitted and prohibited. They are 60 or 70 pages long. As I recall, they must have gone through five, six, or seven drafts. If there was any doubt in my mind or in the minds of other delegates, I put something in brackets.

That was, basically, the working document which I developed within the delegation to help people understand what the treaty meant. Now I understand my files which I left behind at ACDA have been lost.

I do know, because the JCS called me several years ago for the first time with a question on the ABM Treaty, that they then had copies of, at least the last two drafts of my memoranda on the ABM Treaty. The issues at the time, interestingly enough, also related to agreed statement D.

OSD at the time took the position that there was no deployment ban for fixed land-based systems. Under agreed statement D, all you had to do was discuss and there was no limit on deployment. That issue was locked up quickly and I believe it was the arms control impact statement of 1979 that for the first time dealt with that one explicitly.

It was 8 years ago that agreed statement D was being used for exactly the opposite position that it is being used for now.

Senator HART. Were those two memos available to Judge Sofaer or not?

Mr. RHINELANDER. I do not know. Judge Sofaer did not talk to me about this while he was working on it. I first met the judge in London at the ABA convention. At the time I urged him and the legal advisor's office, and I was formerly a deputy legal advisor, to get into the questions because when the SDI Report was written and submitted to the Congress in April, it had not been reviewed outside the Defense Department.

I thought it was important that there be interagency review before any of the important issues be agreed upon. At the time he told me we would get together when we got back in Washington. He never called. I do not know to this date whether he has seen them or sought them. I do know they exist in classified form.

My files were lost. They were shared across the delegation.

Senator WARNER. They were in existence 7 years ago?

Mr. RHINELANDER. I know they exist now.

Senator WARNER. You do know?

Mr. Rhinelander. Yes; I met with representatives before this controversy arose, I met with JCS and OSD. The people in the Government have probed with those of us who are now out trying to find the limits in terms of how we understood the agreement back in 1972.

My response has always been, first of all, take a look at what I wrote in my book chapter and then go to my memorandum. They then asked me questions about footnotes on the memorandum and why I changed footnotes in the last two drafts. OSD and JCS have at least the last two drafts.

People involved in the SALT compliance side of the house I know have been using those as basic documents. I have not seen them. I also do not have access to them any more because I do not have a security clearance.

Senator Warner. We will ask our counsel to get them for the committee.

A question to both of you. I have to think this is a fairly close legal question.

Do you share that view to the extent that you feel that there is enough merit in Judge Sofaer's position that it should be taken up with the SCC?

Ambassador Smith. I do not think so, Mr. Chairman, because the practice since 1972 seems to me to be controlling. If you called in John Foster, who was the leader of DDR&E, and Harold Brown and asked them what guidance they gave to their people in our defensive weapons research programs, it certainly would not be that they had carte blanche to do all the testing and development.

They operated, I am persuaded, under the restricted interpretation. I do not think we need to go to the Soviets and ask their permission or agreement with what happened in 1973. I think it would be straightforward. If we did, they would say we agreed to a restricted interpretation.

I think there are a lot of fine ways we can find this out besides quoting me before some committee as if this was a case of the United States of America versus Smith. That is the way it sometimes sounds to me when I hear these quotations. Ask other people who were involved in it.

I heard today that Paul Nitze wrote the agreed statement D. I have a recollection he did not. A man named Mr. Garthoff wrote much of it. Ask people like Mr. Graybeal and Mr. Carnesale, people who were in the trenches who worked these things out. You will find that the picture, I think, is consistently clear for the old interpretation.

Senator Warner. Do you have any views?

Mr. Rhinelander. Yes, I think the treaty text is very clear on this point. We were very careful with it.

I would also say, though, I am in favor of pinning the Soviets down on very specific agreed interpretations. I think the practice of the U.S. Government reflected in SALT II where there were 98 agreed statements and common understandings, dealing with the detail, is the proper way to go.

The problem is at the time of SALT I the Soviets would not agree to get into the details. The Soviets have now stated they agreed. I still would pin it down in writing. Even if you do that on the first level issue, there are some very, very tough questions related to it. The division point I mentioned.

There is also an issue which I would like to bring to the attention of the committee because it will be helpful in understanding the record and particularly the testimony of Johnny Foster. That is the question of an adjunct. There is nothing in the treaty text of an adjunct.

DOD was very concerned that an adjunct, which was defined as a device which supplemented, but did not substitute for basic ABM components—the example we used was a telescope used in connection with ABM radar—would not be limited to any degree. The Soviets agreed.

I think that is probably in some informal document. It is certainly not in the text. If you look carefully at John Foster's testimony before this committee, both in terms of the fixed land-based lasers and also the lasers on the mobile systems, he was distinguishing fixed land-based lasers for ABM purposes, lasers the mobile and other ABM modes, and lasers as potentially an adjunct to an ABM radar of the kind they used to have out in the Dakotas.

It is important to understand the adjunct concept in looking at the record. As I say, I would pin the Soviets down on these specifics. We have had some examples, as you well know.

One of the examples I flagged in my statement was the second ABM test range where we accepted their finesse, if you will, or silence for agreement, and lo and behold they claimed another one.

I could not stress more, as far as I am concerned as a lawyer, I would like to pin them down to specifics.

Senator **Warner**. Senator Hart.

Senator **Hart**. Thank you, Mr. Chairman.

Gentleman, this is all very esoteric. There are certain theological overtones to it.

There are lots of people in the country who believe and are told by politicians in Washington that the Russians do not pay any attention to treaties anyway and that they have never lived up to them.

We have a letter from the Secretary of Defense which attempts to prove that fact. And here we sit chopping logic over a treaty that is old, and here we are trying to figure out how closely we should follow it.

What is your response to those people in the country or their spokespersons in Washington who say it does not matter anyway because the Soviets do not live up to the treaties?

Ambassador **Smith**. Let me try that.

There is no doubt that the Soviets have taken actions inconsistent with the treaty. I think you have to look at the net performance.

To my mind, in SALT, in the ABM Treaty I, the net performance has been to our security advantage. For instance, the Soviets have decommissioned over 1,000 ICBM's in order to stay within the limits of SALT II. They have decommissioned 13 pretty good ballistic missile submarines, Yankee submarines, that in 1972 we were very concerned about.

We also have cut back in order to stay under the ceiling. The United States does not deploy any ABM systems. The Soviets have deployed less than the 100 permitted.

In 1969 we were looking at estimates that the Soviets would have like 12,000 ABM's by 1975. As a result of the treaty or for some other reason, but I think quite likely the treaty, they have less than 100.

I think you have to look at the whole performance under these agreements and not just say the Soviets do not live up to treaties. I think you will find that they are quite meticulous about material parts of these treaties because I think they see it is in their interest.

I think Senator Wilson raised a point about mobile radars. I think if you look into that carefully, you will find that those are in connection with SAM systems, not in connection with the Soviet ABM systems.

Now, for 20 years we have worried about upgrading SAM systems. I have been hearing about that for a long time. There is no evidence yet that the Soviets have any capability, with SAM's, to negate an American strike. I think if you get the commanding general of SAC in here, he will agree with that.

The SAM systems do not offer a serious threat. Granted we do not like it, but I do not think it is a violation of the ABM Treaty. As I said, when Judge Sofaer was asked by the Senate Foreign Relations Committee, "Do you charge the Soviets with violating this futuristic section of the ABM Treaty?" he said no, and Paul Nitze confirmed that, he said no.

Senator HART. Do you have anything to add?

Mr. RHINELANDER. Let me read one sentence:

> Even a probable Soviet territorial defense would require us to increase the number of our offensive forces and their ability to penetrate Soviet defenses to assure that our operational plans could be executed.

That could have been written in 1967 or 1972. In fact, it was written recently and was part of the compliance report recently sent by DOD to the President.

The Soviets have not deployed territorial defense. You will recall they were the first ones to deploy an ABM system. It was the construction of their system around Moscow which led to the exchange at Glasgow in 1967. Congress provided funds for 3 years before President Johnson responded and Mr. McNamara made his speech in San Francisco.

Among other things, the ABM Treaty has served its basic purpose.

Now, there are troubles with the treaty in that lines have not been clearly drawn. Gerry Smith has referred to the SAM upgrade problem. It was a focus of attention of the U.S. delegation and the Department of Defense in 1972. At that time Soviet systems did not have a great deal of capability in that regard. Their newer systems are more capable, the SA-10 and SA-12 in particular.

Another issue is antitactical ballistic missiles which are not prohibited by the ABM Treaty. The treaty is limited to systems to counter strategic systems. That was done on purpose. We on the

U.S. side wanted to preserve the option to give what is not Patriot capability to deal with short-range tactical missiles.

The Soviets have tested one of their latest SAM systems, SA-X-12, against a short-range missile. Now, that is permitted under the treaty, but I will tell you it will be very difficult to draw a line between a system capable of countering a short-range missile and one capable of countering strategic ones, particularly the submarine-launched ballistic missiles.

If the treaty is to remain in effect, we will have to go back to the SCC and begin to deal with some of these questions. These and other questions I dealt with in my SIPRI paper which is attached to my formal statement.

Finally, with respect to Krasnoyarsk, there is no doubt in my mind Krasnoyarsk is a violation of the agreement. I view encouraging that the Soviets have said they will stop construction of it, but we have four radars, three going up and one which is planned for the United Kingdom which raise questions under that very same article VI(b) of the treaty.

There are some tough issues that have to be dealt with. They are not even dealing with them now with the Soviets.

Senator HART. Has any member of the administration approached you or former members of the SALT delegation on the question of interpretation of the treaty?

Ambassador SMITH. I can answer they have not approached me. I assume they talked to Nitze. None of the others with whom I have talked in the delegation have been approached, of the principal delegates.

There are people still in the Government who were working on the delegation and they may very well have talked to them.

Senator COHEN. Mr. Rhinelander, what specifically was your role during the SALT II negotiations?

Mr. RHINELANDER. I was legal advisor to the delegation. I was one of the three deputy legal advisors at the Department of State.

During the fourth negotiating session in late March or early April 1971 Gerry Smith asked me to come over to Vienna to a session that was going on to begin to draft both an ABM Treaty and the offensive agreement.

The Soviets had earlier tabled their draft of an ABM Treaty. It really was my revisions to that which flagged the whole exotic issue question.

Senator COHEN. You have not been contacted by either Judge Sofaer or administration officials in the process of reexamining interpretation of the treaty?

Mr. RHINELANDER. I spoke to Judge Sofaer in July. I thought we might be getting together.

Senator COHEN. You cited a standard interpretation of treaties as including a look at subsequent behavior and adherence or violation of the treaty as being of relevant importance.

Mr. RHINELANDER. It depends. U.S. courts traditionally have looked at negotiating history, as they look at legislative history in viewing interpretation of a statute. The international practice has been to downplay the negotiating history.

What I was quoting from was the American Law Institute, Foreign Relations Tentative Draft No. 6, which sets forth the basic rules which are being proposed as the U.S. standard.

You also have the Vienna Convention on the Law of Treaties. Subsequent practice is an important factor. People will differ as to how you weigh these in the mix.

Senator COHEN. I was intrigued with Judge Sofaer. I think it is fairly clear that courts traditionally have not held legislative intent with high regard.

Holmes asked questions over the years: What did Congress think? Did they stop to think about what they were passing? This was not a matter of legislative intent. This is a matter of legislative understanding. Not what we intended it was, what we were called upon to ratify.

What was our understanding at the time that treaty was submitted to the Senate for ratification?

Mr. RHINELANDER. I think there are two aspects to it.

One is the understanding we had with the Russians which I would call the negotiating history and the other is the undrstanding the Senate had in conjunction with discussions with the executive.

Senator COHEN. I am focusing on the Senate side. I was interested in what Senator Jackson had to say and what Senator Buckley had to say. I found it somewhat unique because Buckley was opposed to it, he raised the issue of banning futuristic systems. That was a novel construction. I did not know that courts interpreted it in that fashion.

I think congressional understanding is important in terms of our being called upon to ratify treaties--what our understanding was, and what our understanding is in succeeding years as statements are sent such as the arms control impact statement and requests are made for dollars to support various programs.

If our understanding is based on a false premise, it certainly undermines the whole basis of our action. That is why I was concerned about that.

Ambassador Smith, one of the items that constantly comes back to our attention is a statement that you made—cited by, I think, Senator Quayle earlier—that you made in 1972. I will read it to you and ask you to comment on it because it is the subject of some discussion here about your own understanding:

> Now, article II defines what we are talking about and has very important bearing on the whole question of what we call future ABM systems. This treaty has as a most significant aspect that it not only limits the present situation, but has a choking-off effect on future systems which, under the terms of the treaty as we have reached understandings, will not be deployable unless this treaty is amended.

Judge Sofaer's analysis that we have goes on to say:

> It is unlikely that Ambassador Smith, the negotiator of the treaty, would have referred to only a ban on deployment if he had meant testing and development were banned as well. Moreover, Smith failed to refer to article V as relevant to the "choking-off" of future systems.

This is a relevant question. Perhaps you can expand upon it.

What did you mean by that statement and has it been placed in other context or is it inconsistent with your present recollection?

Ambassador **Smith**. I think it was stated today and certainly during this whole discussion there is a good deal of ambiguity in the record. I make no claim that this was a very precise statement.

I have heard recently about the doctrine of imprecision in high places. I think I would have to plead imprecision. I think in other places and certainly in the book I have written on the subject I made it clear that research was permitted, and that was it.

Senator **Cohen**. Which book did you write?

Ambassador **Smith**. It is called "Double Talk."

Mr. **Rhinelander**. Could I add one comment?

I had left Government in June 1972 after the transmittal document was sent to the Hill and before the hearings started. I did not participate in any of the hearings.

I distinctly recall drafting the initial version of the transmittal document signed by Secretary Rogers. It was a very long and very detailed document. It was cut down to no more than one-third of its length by the time it was sent up to the Hill.

That document blurred the issue between the fixed land-based and other modes. There was an implication which I think people read into it, because of the way it was written on future system deployment only with the fixed land-based systems.

A lot of the statements which were written used the exact language of that for the simple reason they did not have to go back and get clearance from the White House; that had already been cleared.

I submit to you the submissions for the record which were made, in particular Mel Laird and the exchanges with John Foster and various members of the JCS or uniform services which are up here, are very explicit.

I do not think there is any doubt that members of the executive branch understood the U.S. position or that members of this committee, the parent committee of this subcommittee, understood.

Now, that is a very separate question from the initial one that Judge Sofaer raises as to whether or not the Soviets have agreed. I would submit you look at the record as a whole. Senator Jackson had a critical role, he was the most knowledgeable person on the committee at the time in terms of the weapon technology.

Senator **Cohen** [presiding]. Senator Levin.

Senator **Levin**. I want to press you on that point about the understanding of the executive branch.

If you have not already commented on this point, I would appreciate your doing so now. I have a document entitled outline of your statement here today. That is what I am referring to. On page 2 it says:

> Part 3. While the U.S. delegation was split in June to July 1971, the President decided to permit development and testing, but not deployment of fixed land-based exotics, and two, to ban development, testing and deployment in bases other than mobile mode exotics.

Have you commented on that today?

Mr. **Rhinelander**. No, I have not.

Senator **Levin**. Would you explain how did the President decide when? Was there some kind of Executive order?

Mr. RHINELANDER. Let me go back and say I also apologize to members of the committee that I sent one copy of my statement up here. I have some more back in the office.

The way the exotic question arose is briefly this. I came over at Gerry Smith's request to prepare a draft of the ABM Treaty and Interim Offensive Agreement for the United States. The Soviets had previously drafted one. Their draft of article III was very permissive and open. I turned it around to roughly the form you have now.

You cannot deploy any ABM system or component except that. I can recall distinctly, in one of the earliest drafts, I wrote a footnote to Gerry this will prohibit future types of technology. It was my redrafting of what the Soviets had originally done which flagged the issue within the U.S. Government. It had not been an issue which had been discussed in the first four of the negotiating sessions with the Soviets.

This led to a review of the question on an interagency basis by the verification panel, eventually a decision by President Nixon.

In Gerry Smith's book he describes the fact that he and Harold Brown were in favor of a broader prohibition. Paul Nitze was in favor of a prohibition excepting space-based sensors. Two other members of the delegation were not in favor of any limit.

The President decided—and partly taking the advice of the Joint Chiefs who wanted to keep open the development and testing of the fixed land-based lasers—the split which we have and which, as far as I am concerned, the agreement we got with the Soviets: a total ban on the mobile and space-based systems and keeping open the developing and testing of fixed land based, provided the testing was done at the agreed test ranges.

Based on my recollection and based on my discussions with former members of the SALT delegation who are now out of Government, including those who worked in the key working group that negotiated this part of it with the Soviets, the Soviets agreed very early on to the ban on exotics in the space-based or any kind of mobile mode.

For 4, 5, or 6 months thereafter the issue was open as to whether they would accept any ban, that is, deployment ban, on fixed land based. That was the issue.

We finally got the treaty text locked up in December 1971 including the comma before the "currently" in article II. The Russians had proposed and we accepted what is paragraph 2 of article I which is a prohibition on a nationwide base or a base for such a defense which dealt in part with the whole question of exotics.

I advised Gerry Smith and other members of the delegation there was no technical need for agreed statement D. The treaty terms made very clear what you could or could not do. That was the derivation of it.

As far as I am concerned, as far as I know, all members of the delegation agreed. During their ratification process the Soviets agreed to that delineation also.

Senator LEVIN. You said the President decided on a ban on development and testing and deployment in space of other mobile exotics.

Is that a Presidential decision you are aware of?

Mr. **Rhinelander**. That was a Presidential decision. The only open literature that describes it, to my knowledge, is John Newhouse's book called "Cold Dawn: The Story of SALT." Let me read two paragraphs. This is from pages 230 and 231 of the book. It is "Cold Dawn: The Story of SALT." I think the date is 1974. It was the first book out, perhaps 1973.

There was a feeling among those of us who had served on the SALT I delegation who had said nothing publicly, and Gerry can give you details. Newhouse had been given access to NSC files because of the details he had in the book.

Let me read this paragraph.

> Perhaps more important than disposing of the zero issue was the discussion on August 9 of futuristic ABM's. Strictly speaking, these are not ABM's because the interceptors would not be ballistic missiles but other more exotic devices, like lasers, charged particles, or electromagnetic waves. Within government, they are lumped together under the term "exotic." While it would take many years, certainly more than a decade, to develop, test, and deploy any one of the exotics, heading them off during SALT was priority business; happily, it was largely accomplished.
>
> NSDM 117 of July 2 proposed to ban exotics by specifying that everything not allowed in a SALT agreement was forbidden. The delegation split on the issue and sent an appeal. NSDM 120 of July 20 did not cover exotics, so, the issue was left hanging until the August 9 meeting during which the State Department, the CIA and ACDA each urged a ban on everything of an exotic nature. The Joint Chiefs opposed the ban, while OSD favored banning novel interceptors, but not some of the related hardware like sensors. The White House staff wished to ban everything except certain research and development; the staff reasoned that for verification purposes, it would be best to have some grasp of the technologies in order to know what to watch out for. ACDA officials conceded that a ban on research and development of exotics could not be verified.
>
> The discussion was about as arcane as might be expected. The President's scientific adviser, Dr. Edward David, was called in and imparted, as one observer put it, a "Buck Rogers flavor to the meeting." At one point, he unveiled the prospect of a "carbon dioxide laser with a circulating medium," to which Kissinger doubtless speaking for everyone, confessed to knowing about carbon dioxide, but about recirculating mediums, not at all.
>
> The White House staff prevailed. NSDM 127, banned everything other than research and development on fixed land-based exotics. There remained to convince Moscow that the great powers should remove exotic future threats to stability, as well as the immediate ones.

Senator **Levin**. Does that reflect your recollection?

Mr. **Rhinelander**. Yes, it is more detailed. I could not quote these NSDM's to you.

Senator **Levin**. Thank you.

Senator **Wilson**. First I guess the only way I can put this is that I would respectfully take issue with the seriousness that Ambassador Smith imputes to what, it seems to me, is a very serious violation and since Mr. Rhinelander has used the term SA-12, that is, in fact, what we are concerned about.

I am constrained by the fact that we are talking about classified material, so I will not attempt to say I do not agree that there is no evidence that these are available for a purpose other than air defense. That is why I do think that it amounts to a very serious violation. In fact, it would seem to me to be one more serious potential even on Krasnoyarsk.

I was struck by a statement that was made, I think by Mr. Rhinelander rather than Ambassador Smith, but both of you, it seems to me, have placed a heavy emphasis upon Soviet words and Soviet conduct in the period since the signing of the treaty. And, in particular, Mr. Rhinelander, you made the statement that Soviet conduct has been consistent with the restrictive interpretation since the treaty.

The suggestion was made that we should have tabled this with the SCC. Let me just ask you if the Soviets are in violation of the treaty, even under the restrictive interpretation, how can we reasonably expect that we will get anything but self-serving responses from them if we ask them what their interpretation was when it is broached to them under the SCC?

Very frankly, my conversations with our delegates, which I agree are extremely confidential, have not encouraged me to believe that they would make a clean breast of it.

Mr. RHINELANDER. Let me respond.

With respect to lasers, the Soviets clearly have had a large laser program for a number of years including Sary Shagan. We identified them in six different places in one of the books I wrote. It is in the open literature.

With respect to the lasers or the exotics, once more generally I believe there is no question that they have conducted their programs consistent with the treaty. The treaty permits testing of fixed land based.

Clearly, the Soviets emphasis over time has been more land based than space. I think your question goes to other parts of the treaty rather than the exotics. Let me deal with the SAM upgrade and the large radars.

The heart of SDI, as you know, includes systems that could be used to defend against Soviet short- or medium-range missiles in Europe. Those are some of the systems in that program.

The U.S. Government has to take the position that it is permissible to develop, test and deploy defensive systems against short-range tactical ballistic missiles. They are not in a position, if treaties are to apply equally to both sides, to deal directly with the SA-12 question.

My problem is I think both sides are going for programs which I think are going to undermine the treaty. I think the SA-12 one is serious, not that it is a violation of the treaty. They have not tested it against strategic ballistic missiles.

The problem is that you are not going to be able to distinguish. If a system encounters an SS-20, it has a capability against an SLBM missile. The problem ought to be closed if the treaty is to remain in effect.

With respect to the large radars, while Krasnoyarsk is a clear violation as it is being constructed, we are building four, we are building three and proposing a fourth, which raise serious questions under the treaty, not the flagrant one at Krasnoyarsk.

The Krasnoyarsk radar is in the wrong place pointing in the wrong direction, the kind of thing which could have a military significance. A phased array radar in Thule, Greenland, does not have a lot of military significance other than early warning, but it is a legitimate question under the treaty and on other agreed statements as to whether we are permitted to replace the old kind of technology, and the old system we had before 1972, with a phased array.

These are questions which have to be addressed. They are not simply one-sided.

Senator **Wilson**. Ambassador Smith, actually I would have to take issue about your self-deprecating comment that you think you have been guilty of imprecision.

The memorandum that the legal advisor from the State Department has supplied quoted statements made by you in the period of time between signature and ratification in comments to the Senate Armed Services Committee, to the House, and in other places in which I think to the contrary, you were quite precise.

The point which the memorandum makes and it seems to me makes fairly, is that as our negotiator and as someone knowledgeable in written materials, in particular, where you have seemingly taken the pains to talk about deployment, it is a just and fair inference to conclude that what you were saying is that the present interpretation; that is, the so-called broader interpretation, permitting testing and development was not at the time something that you thought to be prohibited.

I do not think that is unfair. I do not know that you have any such plans, but if you do not like hearing yourself quoted back to yourself, I urge you never to run for public office. It is an occupational hazard.

But in all seriousness, what other interpretation could be placed on those statements?

Senator Quayle has read you one, Senator Cohen has read you another. I assume you have seen this document.

Ambassador **Smith**. Yes; I think the best answer to your point, Senator, is that the Senate apparently did not get that impression at the time.

If you read Senator Jackson carefully, and he was the most knowledgeable fellow in this field and we testified before him for days, he never got the impression that from my statement I was urging a broader interpretation than the military reporting to him.

If there was a broad interpretation, one would have thought the military would make that case, not the civilian side of the House.

Mr. **Rhinelander**. Could I add one point to that?

I cannot say I have read all the hearing record, but I have read most of it and I agree there are a lot of statements that are ambiguous. There are two points to make.

The focus at the time in DOD, and clearly the focus of the Soviets, was on fixed land-based systems. DOD wanted to go forward with development and testing and did not want to be foreclosed on that. But there is a blur.

The blurring comes up because the question is whether those general statements which were directed at, but sometimes not explicitly described in terms of fixed land based, also ought to be looked at in terms of the other basing modes.

I would submit to you that I do not know of, and I have not heard yet today, any statement that in any record affirmatively stating or suggesting that the space-based systems could be developed, tested, and deployed, exotic-based systems. I do not think that is there.

When you get to the submissions for the record which were combed over on an interagency basis before sent up, including one sent up by Secretary Laird to Senator Goldwater, it is very clear.

Finally, there is the famous statement for the record in terms of the dividing line between research and development. That would not have been significant at all unless the explicit or implicit understanding was that exotics were banned in terms of article V at that point that you could verify it.

The issue was what was the dividing line between permitted reseach and prohibited development.

Senator **WILSON**. Thank you very much.

Mr. Chairman, let me just ask one more question.

I guess the reason we do not have Mr. Rhinelander's detailed memorandum, and I gather that is what you have, Carl?

Senator **LEVIN**. I have an outline.

Senator **WILSON**. I assume we will all have it. I assume it got here too late for reproduction. Anyone who had done that much work deserves to be read.

Gentlemen, thank you.

Mr. **RHINELANDER**. I have a few more copies in my office.

Senator **QUAYLE**. Let me join Senator Wilson's point on this.

I agree, Mr. Rhinelander, that it is there, it has been tested against ballistic missiles, the SA-12. I also believe that it is a threat to the P-2, SLBM, and those that say that there is very little ballistic missile defense in the Soviet Union going on, whether it is violation or not, it certainly is there.

Ambassador **SMITH**. I said strategic ballistic missiles. I have not heard any indication about the need for new pen aids for our SLBM's because of the SA-11.

Senator **QUAYLE**. You may hear about that. You may hear arguments about that. The fact is that they have been testing against ballistic missiles. They do have strategic ballistic missile defense against SLBM's.

The people who say they do not, are misstating the facts. The Soviets have tested the SA-12's in the ABM mode. The record should show I agree with Mr. Rhinelander on that point.

Mr. **RHINELANDER**. When we have used the phrase "tested in an ABM mode," we have always used that as shorthand for testing in an ABM mode against strategic ballistic missiles.

Obviously, you cannot test non-ABM systems against strategic ballistic missiles. If we keep upgrading the technology, or the Soviets keep upgrading their technology, this treaty will go down because of the ATBM faster than SDI.

Senator **QUAYLE**. The potential that people are concerned about is creep out. You know what I am talking about. Krasnoyarsk does have strategic ballistic missile defense relevance now.

I think Senator Cohen brings up a good point, the fact that we have to go back and understand what the Senate really agreed upon.

Senator **COHEN**. An amazing confession, by the way.

Senator **QUAYLE**. I think we have to try to understand that we lacked information on the issue of testing and development on that precise issue.

Agreed statement D, Ambassasdor Smith says, was not precise. He keeps referring to Senator Jackson in his testimony.

Senator COHEN. Could I interrupt for 1 second?

I have found that in the whole process of ratification of any treaty there is always ambiguity. The reason you have the ratification process is to clear away any misunderstanding. We had it in SALT I, SALT II, and we are experiencing it now with the agreement between the Chinese and the United States on nuclear cooperation.

In this process of going through and saying what do you really mean, quoting there by Jackson, Goldwater, the other parties, General Palmer and others, you finally come to an understanding as to what you are voting on. That is the process of ratification.

Senator QUAYLE. I think there is very little in the record that says the only thing that we were prohibiting under agreed statement D was land based. Senator Jackson went on and talked about the other things.

Mr. RHINELANDER. I think you are correct. I do not think any testimony talked about agreed statement D.

Senator QUAYLE. They did not focus on it.

Mr. RHINELANDER. We did not distinguish between that. As I said, the way we wrote the treaty and the advice I gave Gerry Smith and others was that we did not need agreed statement D. Under the treaty text, article III, you could develop and test, but you were prohibited from deploying, the exotic fixed land based. Article V took care of the rest.

Senator QUAYLE. We had to push on with agreed statement D because the Soviet Union was opposed to our proposed outright ban?

Mr. RHINELANDER. There is no question.

Senator QUAYLE. We were the ones that were pushing the ban, the total ban, and the Soviet Union said, nonsense, that since we do not know what we are talking about, we are not going to ban future systems.

They simply would not go along with what our negotiators were pushing. When I try to understand what we agreed on, we did not have the discussion in the Senate because we agreed to give up ABM. We did not know what future systems were out there.

Mr. RHINELANDER. The most important witness in this regard when we got down to details, some of which are classified, was John Foster. He was the Under Secretary for DDR&E in Defense. He knew exactly what the rules were and, in fact, when you follow the hearing through as much as has been printed in the public record, Senator Jackson is, in fact, leading him at one point when they are moving back and forth on discussions between fixed land-based and mobile exotic systems.

Given the ambiguity, which I agree is in the record, there was no doubt among members of the committee as to what the U.S. view was.

Judge Sofaer's basic point is something else. I submit that is clear in the text of the treaty. As far as I know, the negotiating record supports that.

Senator QUAYLE. The Soviets did not accept it?

Mr. RHINELANDER. I think they did.

Senator QUAYLE. We have to come back to see what agreed statement D means. That is what this whole discussion hinges on.

What does agreed statement D mean?

It does not specify only the fixed land-based system. It does not say that. It says other physical principles including components, launchers, and radars created in the future.

Do you agree with Judge Sofaer that Paul Nitze was the basic author of this?

Mr. RHINELANDER. No. Ray Garthoff in fact wrote agreed statement D.

Senator QUAYLE. Did he have anything to do with it?

Mr. RHINELANDER. Yes.

Ambassador SMITH. May I add that Nitze as recently as 7 years after the treaty wrote that the thought agreed statement D was unnecessary.

Senator QUAYLE. That is not the point. I am sure you would think it would be unnecessary because it goes against what you would like to see.

Ambassador SMITH. Is the one man who changed his mind and now supports the new——

Senator QUAYLE. He supports the legal interpretation.

Mr. RHINELANDER. He wrote in 1977 that agreed statement D was not necessary.

Senator QUAYLE. Why was it written?

Mr. RHINELANDER. We had sought much more detail across the whole spectrum of both agreements. When we originally drafted them, the Soviets objected to detail. We could not get it in the treaty.

Some of that we got back in the agreed statements on both sides. We have the ban on the MIRV'ed ABM interceptor which is agreed statement E, or so. On this one we thought it was important to have some document which reflected confirmation of article III and article I. This was the purpose of it.

I think the negotiating record will support that what we, the United States, were doing were seeking an agreed statement supporting article I against a base for a nationwide system and article III which you are familar with.

What we have there is a combination of language drafted first by the Soviets and then by us. We had prepared three or four drafts of agreement statement D, very clear.

I can tell you, although I do not recall the exact language, the Soviets objected over 3 or 4 or 5 months. They finally agreed and they came back with their draft. We kept sending it back.

In the final analysis it was Ray Garthoff who put together the physical principles concept. The leadoff clause to agreed statement D was written by the United States. It was added onto the language that the Soviets had proposed because we wanted to pin it down to article III. It was reinforcing article III.

Why did we have that rather elliptical language in the back talking about discussions and amendment?

The fact is from the Soviet point of view they wanted to make it understood that it would be possible to discuss this and come up with an amendment to the treaty later on.

We said, sure, you can discuss anything you want and we can get an amendment. So, they wanted it stated in this rather convoluted form. I agree it is not clear.

I will tell you, as far as I am concerned, the treaty text is clear and the purpose behind that was very clear. I find it extraordinary to turn it on its head.

Note the basic argument of Judge Sofaer does not revolve around agreed statement D. It is article II, the definition, the comma, the "concurrently consisting of." He reads an "and."

I think even he would agree, that if you read article II on the definitions differently, then agreed statement D is basically meaningless.

Then he says why would you come up with something that is not necessary? And to give it meaning, he turns the treaty on its head. That makes no sense in terms of what we did and in terms of the matter of construction.

My statement takes it through—I know it is unfair because you do not have a copy of it—I take it through how the whole treaty was developed. I do not have access to the record. You will have to get the people involved.

Senator COHEN. For the record, could I request all of the relevant 1973 national security decision memoranda for review by the committee so that we will have access to that?

Senator WILSON. Did I understand that you said that the United States added the preliminary phrase "In order to ensure"?

That was added by us to what follows, which I gather from what you are saying was what was insisted on by the Soviets in agreed statement D.

Mr. RHINELANDER. The language, of course, involves inputs from both sides. The basic leadoff clause was one that we drafted.

One of the interesting things, and you noted the word "create" later on in that agreed statement D, that is a word which has raised the problem under article V. I do not speak Russian, but the Soviet word for "develop" used in article V is "Sozdavat," which literally is translated to "create."

What I see here in agreed statement D is really the translation back in English of a text that was originally drafted in Russian. We added to that that leadoff clause to pin it down. It is not elegant. I will be the first to admit that.

Senator WILSON. The rest was original drafting in Russian?

Mr. RHINELANDER. It went back and forth. You will have to talk to Ray Garthoff. We had instructions from the President, signed by the President. It would be the delegation, Gerry Smith and other delegates, who would then make decisions overseas as to how we would carry them out.

Negotiations were not necessarily handled by Gerry or other delegates. It would be a working group that worked with article V. We had drafting groups. We had things that went before interpreters.

With respect to agreed statement D, it was principally handled by Ray Garthoff with his counterpart from the Soviet delegation, Nikolai Kishilov. They were acting in both cases for the delegations. What they produced would come back for approval by the delegation.

Senator QUAYLE. At any time was the language of fixed land-based systems in the proposal?

The reason I ask that is because that is what you say it means. If that is what it means, I presume it was in there sometime. If not, why not, and if it was, why was it taken out?

Mr. RHINELANDER. I do not know the answer to your question. I do know——

Senator QUAYLE. Wouldn't that be a fundamental point?

Mr. RHINELANDER. Not necessarily.

Senator QUAYLE. That is your contention, agreed statement D does not allow?

If that is your point, I cannot believe that was not discussed in some detail with all the going back and forth.

Mr. RHINELANDER. There is no doubt in my mind at all that the negotiating record would show that the referral is to article I and article III.

Senator QUAYLE. I am talking about in draft.

Mr. RHINELANDER. It was not in there. That goes back to the way it was drafted originally. The original draft the United States proposed is quoted in Gerry Smith's book "Double Talk." I have it somewhere in my full statement. It was originally the third paragraph of what is now article V. I think it was then article VI, but the numbers changed.

The second paragraph of that current article V deals with rapid reload and a variety of other characteristics, all of which modify the fixed land-based systems. The paragraph we originally drafted to deal with the exotics was paragraph 3. It did not have any reference to fixed land based.

As I believe you have noted earlier, while article III deals with fixed land based, because that is all that is left over, there is no reference in the treaty itself to fixed land based. That is, the only thing you can deploy is fixed land based because all the other basing modes have been locked by article V.

Senator QUAYLE. Obviously, times have changed since 1972. There is much more interest in the issue. The committee has been spending hours on it. Probably there will be more debate.

I certainly appreciate your contribution and your coming here today. It will probably not be the last time. This issue goes on and on. You were there and I appreciate your comments.

Senator WILSON. Mr. Chairman, may I presume just a little further on the good humor of our witneses? I will not keep you long. You have been generous with your time and stamina and your service to your country.

I am intrigued by the comment that this agreed statement D which Ambassador Smith and you, Mr. Rhinelander, and others apparently, have felt to have been, call it what you will, superfluous. This is the argument you have touched on so far as analysis.

It occurs to me that it might well have seemed so from your point of view. I am intrigued by the fact that after the introductory phrase upon which you insisted what follows was originally drafted in Russian.

I cannot help wondering if your feeling that it was superfluous may not have never met, never coincided with the Soviet intention to add a second portion, really operative language of that agreed statement D that I agree with Mr. Levin seems quite contradictory.

In other words, after the phrase that you insisted on, what follows really does seem to be somewhat disconnected. The statement that Judge Sofaer makes about his analysis of a negotiating record makes me wonder.

You cannot help but wonder, based on what he said, if the Soviets did not think it was not superfluous, but it was necessary in order to give them an out with respect to those future, then unknown technologies which they did not wish to eschew.

Ambassador SMITH. I do not think I have any recollection in 1972 that the agreed statement was superfluous. I was using that to describe Paul Nitze's state of mind 7 years later or 5 years later.

Senator WILSON. Mr. Rhinelander said he thought it was redundant.

Mr. RHINELANDER. I can recall—I do not know if it is in writing anywhere—advising it was not necessary because of the way the treaty text was drafted.

I also know that the key words in the treaty, "except" in article III, "currently consisting of," in article II and language for article V were all completed before we got to agreed statement D.

Senator WILSON. The emphasis for agreed statement D came from the Soviets?

Mr. RHINELANDER. No; the United States was pushing.

Senator WILSON. Who pushed for it?

Mr. RHINELANDER. The United States delegation did.

Senator WILSON. For agreed statement D?

Mr. RHINELANDER. Yes. We pushed for all but one of the agreed statements in the ABM Treaty. The Soviets pushed one.

Senator WILSON. Perhaps I misunderstood. I thought that the language that follows the comma after the "in order to assure," I thought you said was first drafted in Russian?

Mr. RHINELANDER. No; the "currently consisting of," that language which is in article II, definitional article in the ABM Treaty, was U.S. language.

Agreed statement D, there had been changes going back and forth for months. You ought to get Ray Garthoff up here and do it in closed session because he was the one directly involved in handling this with the Russians.

My recollection is there was at least three or four separate drafts which we had prepared, all of which I assume, and I hope, were very clear, but the Russians were not buying the concept.

It was not a question of language. They finally came back and they said, yes, we accept it, and they came back with their own draft and their own draft was one that was unacceptable to us.

I do not know how many times it went back and forth after that. I know the language we drafted was the language up front. Then we clearly got changes to some of the language they drafted.

It is not an ideal, clear statement, I agree with that. If you get Garthoff up here and ask him to explain in closed session what went on, it will all fall into place. There is no doubt in my mind that the United States from the very beginning to the end was pushing agreed statement D to supplement, to reinforce, article I and article III.

Ambassador SMITH. Senator, I would stress that you are probing memories now of 13 years ago. There are people with access to documents. I think that is a much better way to trace this record.

Senator WILSON. That is a good suggestion.

Gentlemen, thank you. You have been generous and hardy. I am sorry that we have detained you so long, but it is a subject of understandable interest.

[Questions for the record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

DOUBLE STANDARDS

Senator WARNER. You have stated that one reason for the administration's review of the ABM Treaty limitations on exotic technologies was to prevent a "double standard" from developing. Yet haven't we created a double standard whereby the Soviets are free to pursue their strategic defensive programs in a more permissive manner than we are permitting for ourselves?

Judge SOFAER. No. Under our interpretation of the AMB Treaty, neither side is legally restricted by the AMB Treaty from engaging in research, development, or testing of strategic defensive programs based on "other physical principles." Nevertheless, as a matter of policy, the President has decided not to exercise that freedom, directing instead that the SDI program be pursued as currently structured, which can be accommodated within the confines of the "restrictive" interpretation. We expect the Soviet Union to exercise similar restraint in its defensive efforts, given its recently stated interpretation that development and testing of future space-based systems are banned by the Treaty. Should the Soviet Union pursue such development and testing, then the President and Congress would consider such Soviet action in reviewing U.S. policy.

Senator WARNER. What would be your views about an effort by some in the Congress to bind the administration to the more restrictive interpretation of the ABM Treaty?

Judge SOFAER. Such as effort would be harmful to U.S. strategic interests. It could impose a binding unilateral restriction on our Government's strategic options, without limiting Soviet options. Moreover, such legislation is unnecessary. The President has affirmed that he intends to pursue the SDI research program as currently structured, which is consistent with the "restrictive" interpretation. Should a future Administration seek to implement the broader interpretation, the Congress would have a voice in that decision.

Senator WARNER. As an expert in international law, should the notion of "military significance" be used as a criterion in determining whether an arms control agreement has been violated?

Judge SOFAER. Whether a violation of an arms control agreement has occurred is judged by reference to the agreement's terms, without reference to the "military significance" of the violation. The "military significance" of a violation is taken into consideration in determining the appropriate response to the violation.

Senator WARNER. Ambassador Smith, during the period immediately following the signing of the ABM Treaty, there were a number of administration statements, including your own, that mention future systems only in the context of deployment restrictions. How do you account for the fact that these doubtlessly carefully crafted statements are not explicit about development and testing of the so-called exotic technologies if that was the intent of the signatories?

Ambassador SMITH. On May 26, 1972 at a Moscow press conference with Henry Kissinger immediately after the signing of the ABM Treaty, my extemporaneous remarks included:

"Now, *article II* defines what we are talking about and has a very important bearing on *the whole question of what we call future ABM systems.* This treaty has as a most significant aspect that it not only limits the present situation but has a choking-off effect on future systems which, under the terms of the treaty as we have reached understandings, will not be *deployable* unless this treaty is amended." (Emphasis added.)

The second sentence refers to deployment and correctly notes that the deployment of exotics is banned. I was clearly referring to fixed land-based systems. My first sentence makes clear that Article II contains the key definitions relating to "exotic" systems and the Treaty as a whole. While I did not refer to Article V in my Moscow comments, the reference to Article II—which contains the functional definition of ABM systems and components—seems quite clear thirteen years later.

The submittal letter of June 10, 1972 from Secretary Rogers to President Nixon contains the most detailed analysis of the ABM Treaty in the initial documents prepared for the Congressional hearings. This document refers to the definitions in Article II as functional. (See Senate Armed Services Committee Hearings, pp. 79, 81.)

The emphasis in the submittal letter, and statements to Congress by Secretary Rogers and myself, on the deployment ban on "exotics" rested on the fact that the broad ban on space-based "exotics" had not been an issue in the U.S. government (including the JCS and OSD) after President Nixon made his key decision in early August 1971. The Soviets had agreed to the ban on space-based "exotics" by September 1971. The running issue with the Soviets was whether the deployment of fixed land-based "exotics" wold be prohibted. They were agreed to by December 1971. Under the Treaty, the Army was permitted to continue its classified research and development progam on fixed land-based lasers.

On re-reading the Senate hearings, neither John Rhinelander nor I have found any testimony stating that the development and testing, as well as deployment, of space-based "exotics" was permitted. The focus of much of the hearings was on the development and testing of fixed land-based lasers. An early misunderstanding during the Armed Services hearings arose because Senator Jackson had put out a statement saying a laser contract had been canceled. Secretary Laird denied this (Senate Armed Services Hearings, p. 30). I informed Senator Goldwater that development of lasers was permitted by the Treaty (p. 306). It is.

Because of imprecision of language I admit that some statements do admit of an inference that development of "exotic" systems, however based, might be permitted by the Treaty. But it hardly affords a basis for concluding categorically that such development is permitted under Article V or, more improbably, that Article II and the entire text of the Treaty do not cover "exotics", as the Administration now contends. While proponents of the revised interpretation cannot cite any statement that development and testing of space-based exotics is permitted, the record of the Senate Armed Services Committee contains a number of authoritative statements that such development and testing is banned. They include Secretary Laird's very precise answer for the record in response to a question from Senator Goldwater (pp. 40-41); as well as the remarks of John Foster (pp. 222, 274-75) and General Palmer (pp. 437-44, especially p. 443). The clear statements by Defense representatives responsible for US programs, together with the functional definition in article II and the flat language of article V banning development, testing and deployment of space-based "exotics", which were described in the submittal letter, makes the inferential argument from some of my statements seem rather flimsy.

Finally, if the Treaty text only covered traditional technology and the only limits on "exotics" arises because of Agreed Statement D, as the Administration now contends, I would have expected that every member of the US delegation, and every witness, would have made that very fundamental point, and Senator Jackson and others would have picked up on it. None did.

Senator **Warner**. Ambassador Smith, in your book "Double Talk," you state that, "The ABM futuristic question was now resolved to our satisfaction. The Soviets argued that including unknown matters like future ABM technology in a treaty would create endless arguments and suspicions. The sides could not discuss questions not known to anyone. Our task was to limit deployment of known ABM components."

This quote suggests a view closer to the administration's. How do you explain this?

Ambassador **Smith**. In your question you quote from page 343 of "Double Talk." It seems clear to me that the sentence, "Our task was to limit the deployment of known ABM components" was a description of one of the Soviet arguments and not a conclusion of mine.

In any event, selective quotation of this sort should hardly be evidence for interpreting a treaty contrary to the accepted interpretation of some thirteen years standing.

Perhaps a better indication of our state of mind in the Delegation is a statement on page 264 paraphrasing a message to the White House: "There would be Congressional criticism of an approach limited just to existing types of ABM systems. More importantly, if we did not get a ban on futuristics, in a short time there would be a competition in them just like the one we are presently trying to stop. What was the logic of trying to ban the upgrade of anti-aircraft systems while allowing testing and deployment of future types of ABM systems?" And also on that page, "It is easier to control weapons before they come into being than after."

In addition on page 264, consider the following language: "Finally, since research on future systems would not be limited, the United States would have insurance against their possible deployment by the Soviets in violation of a ban." That certainly suggests that anything beyond research was banned.

And consider the following on page 264: "It posed a basic question—did we seek an ABM constraint to provide greater stability by assuring maintenance of retaliatory capability, halting a buildup of defensive systems that could threaten that capability, lessening pressures for unnecessary buildup of offensive systems—or were we looking for just a temporary truce on ABMs until such time as more effective futuristic systems were developed and deployed? The latter approach ran counter to U.S. strategic policy and public statements on the destabilizing effect of nationwide ABM defenses. It could well lead to a race for futuristic systems and merely put off the danger we were trying to preclude in SALT. If future ABM systems were not to be limited, the onus should rest on the U.S.S.R."

KRASNOYARSK RADAR

Senator WARNER. Ambassador Smith and Mr. Rhinelander, do you both agree that the Krasnoyarsk radar is a violation of the ABM Treaty? If you were advising the President, what steps would you recommend that he take to resolve this violation—other than raise the issue before the SCC which to date has failed to resolve it?

Ambassador SMITH. I agree with Mr. Rhinelander's answer to this question.

Mr. RHINELANDER. Both sides are taking actions which are either violations of or raise significant questions under Article VI(b) of the ABM Treaty.

From its siting, orientation, elevation of its one active face, the apparent similarity to Pechora-type radars, and the gap it fills in present early warning coverage, the Soviet phased-array radar under construction near Krasnoyarsk appears clearly to be for early warning of strategic ballistic missiles. Therefore, its construction amounts to a violation of Article VI(b) since it is neither on the periphery nor oriented outwards. The violation occurs with the construction of a prohibited radar and not just when the construction is completed (which may be in two or three years for Krasnoyarsk) or when it is turned on.

Because the two active faces of the triangular-shaped PAVE PAWS radars under construction in Georgia and Texas provide significant "back" "over-the-shoulder" coverage of interior portions of the United States, these radars raise the question whether they are oriented "outwards" as required by article VI(b). The replacement early warning phased-array radars nearing completion at Thule, Greenland, and may be operational in October 1986, planned for Fylingdale Moors in the United Kingdom (the UK has not yet approved and construction has not started), raise the question whether any phased-array radars may be constructed outside national territory for early warning purposes under article VI(b) and Agreed Statement F.

My summary views, reflecting my detailed but classified advice to the Salt I delegation, on the general issue of early warning radars are included in the 1972-73 chapter I wrote (pages 137-38 of Exhibit E to my statement). My current views on this issue are in my SIPRI paper (pages 3-4, 7, 11, 19, 24, and 24-27 of Exhibit F to my statement). The US and Soviets currently interpret the ABM Treaty loosely with respect to some of their programs, but restrictedly with respect to the programs of others.

The Soviet justification that the Krasnoyarsk radar is for space track and therefore permitted under Agreed Statement F is not persuasive on the facts. The US justification of the two additional PAVE PAWS raises both factual questions and an interpretation issue (how much back coverage is permitted). The US justification of the Thule and Fylingdale Moors phased-array radars raises a not insubstantial legal question under both the Treaty and Agreed Statement F.

If I were advising the President, I would urge that all these issues be dealt with in the SCC and:

(1) the US insist that the Soviets dismantle the Krasnoyarsk radar on the assumption that there is no technical fix to focus its capabilities on space track;

(2) the US be prepared not to go forward with the planned radar for Fylingdale Moors if the Krasnoyarsk issue is satisfactorily resolved;

(3) the US and Soviets agree that no additional new large phased-array radars, for whatever purposes, be constructed, that Agreed Statement F be tightened, *and* additional agreed statements be agreed upon related to "back coverage" and similar issues (see my SIPRI paper, Exhibit F, and pages 67-75 of Exhibit I to my statement).

QUESTIONS SUBMITTED BY SENATOR SAM NUNN

Senator NUNN. Would you agree that the purpose of the Senate's extensive ratification hearings on the ABM Treaty was to clarify ambiguities of interpretation?

Judge SOFAER. The Senate held extensive hearings to develop a detailed understanding and assessment of the two SALT I agreements. Although this process may have helped to answer questions in particular Senators' minds, it could not result in authoritative clarifications of any ambiguities in the Treaty, because statements made during the hearings were unilateral.

Senator NUNN. Would you agree that by the time the Senate voted on the Treaty, Senators, such as Senator Buckley, were firmly of the view that the Treaty prohibited the development and testing of space-based laser ABMs?

Judge SOFAER. Senator Buckley apparently feared that the Treaty would prohibit development and testing of space-based laser AMSs. Whether other Senators held this view is unclear.

Senator NUNN. Your office's analysis of post-negotiation statements cites Senator Fong's floor statement that the Treaty "allows research and development on ABM systems to continue, but not the deployment of exotic or so-called future systems."

Did Senator Fong ever say that "only" the deployment of exotics was banned?

Judge SOFAER. That is the logical reading of his remark.

Senator NUNN. Since the Treaty permits development and testing not only of conventional ABMs but also of fixed, land-based laser ABMs, why do you read so much into Senator Fong's statement that R&D on ABM systems can continue? Why should this be read as suggesting that Senator Fong thought that development or testing of space-based lasers was permitted?

Judge SOFAER. Senator Fong's statement does not distinguish between fixed land-based systems and other basing modes, but instead addresses all future systems.

Senator NUNN. In your office's analysis of post-negotiation public statements, you cite Ambassador Smith's May 26, 1972 press conference statement that "Article II defines what we are talking about and has a very important bearing on the whole question of what we call future ABM systems." Why shouldn't this be read as indicating quite clearly that Article II covers ABMs based on future physical principles, as well as those then-current?

Judge SOFAER. Ambassador Smith said that article II has a bearing on what constitutes a future system, not that article II encompasses future systems within its definitions. What will be considered a system covered by the Treaty obviously is relevant to the treatment given future systems.

Senator NUNN. You attach great weight to Ambassador Smith's statement that "future systems . . . will not be deloyable unless this treaty is amended." You say that it is unlikely that Smith would have referred to only a ban on deployment if he had meant testing and development were banned as well. Since deployment [sic] and testing of exotics systems is permitted under the restrictive view (provided the system is fixed, land-based), why would Smith have said that development and testing of exotic systems was banned?

Judge SOFAER. My memorandum does not attach "great weight" to any particular statement or, for that matter, to unilateral post-negotiation pronouncements. Ambassador Smith did not draw any distinction in the treatment given to future systems due to their basing mode. Were the "restrictive" view correct, it is reasonable to expect that he would have mentioned a fairly significant ban: on the development and testing of all air-, sea-, space-, and mobile land-based future systems. The consistent absence of any reference in Ambassador Smith's statements to any limitations on the development and testing of future systems supports the "broader" view of the Treaty.

Senator NUNN. The administration has placed great weight on Soviet Defense Minister Grechko's statement in September 1972 in which he said that the Treaty "imposed no limitations on the performance of research and experimental work aimed at resolving the problem of defending the country against nuclear missile attack."

In your view, does this statement suggest that at the time the Soviets ratified this Treaty, they believed there were no restrictions on the development and testing of exotic ABMs?

Judge SOFAER. The statement is ambiguous, but it suggests that the parties retained significant freedom with respect to future systems.

Senator NUNN. When did the Soviets begin research on a ground-based laser ABM weapon?

Judge SOFAER. I am informed that the Soviets began work in the mid-1960's on a ground-based laser weapon with possible ASAT and ABM applications.

Senator **Nunn**. At the time Grechko made this statement would he, as Defense Minister, have been fully informed about this program?

Judge **Sofaer**. The Soviet Defense Minister presumably would have been aware of the program.

Senator **Nunn**. Am I correct that under the so-called restrictive interpretation, the Soviets would have the right to develop and test ground-based ABM laser weapons at agreed test ranges, such as Sary Shagan?

Judge **Sofaer**. Yes.

Senator **Nunn**. Why, then, can't Grechko's statement be read as simply assuring his comrades that the Treaty they were about to ratify would not interfere with their ground-based ABM laser program at Sary Shagan?

Judge **Sofaer**. Nothing in the statement limits its application to that system. Both U.S. and Soviet officials were aware in 1972 of the possibility of future space-based systems, including lasers.

Senator **Nunn**. Can you cite any statement by Soviet officials in the 1972-1985 time frame in which that official explicitly states that the Treaty does not restrict the development and testing of space-based or other molbile ABM systems or components that are based on other physical principles?

Judge **Sofaer**. We cannot point to any such public statement, but I am aware of at least one such nonpublic statement made by a Soviet official prior to the announcement of this Administration's interpretation of the Treaty. Of course, what is of critical significance is that fact that, during negotiation of the ABM Treaty, the Soviets consistently refused to agree to U.S. proposals for specific language establishing such a restriction.

QUESTIONS SUBMITTED BY SENATOR CARL LEVIN

Senator **Levin**. John Rhinelander testified that President Nixon decided in the summer of 1971 to ban the development, testing and deployment of space and other mobile-mode "exotics." He said an accurate description of that decision appeared in a book called "Cold Dawn" on pages 230-31. Were you, at the time you rendered your opinion, familiar with this account? Is it relevant to a full consideration of this issue?

Judge **Sofaer**. Although I had not read this particular book, I was familiar with the U.S. Government's instructions to its negotiating delegation. These instructions are relevant to a full consideration of the issue, but must be considered along with the Soviet opposition to restrictions on future systems and subsequent U.S. acceptance of some Soviet positions on the subject during the negotiations.

Senator **Levin**. If the first 25 words (hereinafter called the "first part") of Agreed Statement D refer to "conventional" ABM systems (i.e., those based on them current physical principles), how can it be said that the balance of that Agreed Statement (hereinafter called the "second part") which in your opinion refers to "exotic" ABM systems (i.e., those based on "other" physical principles), insures fulfillment of an obligation relative to conventional systems in article III?

Judge **Sofaer**. The question implies that some inconsistency exists in this reading of Agreed Statement D. On the contrary, the broader interpretation provides a coherent view of that Statement. Article II bans the deployment of any "conventional" ABM system or components, except as specifically permitted by that provision. Agreed Statement D seeks to "insure fulfillment" of that provision. The parties recognized that "exotic" systems may be created and that they would not be covered by article III. Accordingly, the parties agreed not to deploy such "exotic" systems without prior agreement on "specific limitations." In short, Agreed Statement D strives to prevent the article III deployment ban from being circumvented by the creation of new defensive technologies based on other physical principles that the "conventional" systems. The provisions are complementary, not inconsistent.

Senator **Levin**. The second part of Agreed Statement D, which you testified is the only language in the treaty relating to exotics, says that specific limitations on such systems would be subject to discussion and agreement in accordance with articles XIII and XIV. What is the basis for your conclusion that said limitations relate only to limitations on development and testing and not also to limitations on deployment?

Judge **Sofaer**. The question misstates the administration's position. Agreed Statement D does not ban development or testing of "exotic" systems, but does ban deployment of them absent agreement between the parties. The "specific limitations" referred to in the second part involve the particulars of any deployment that the parties might agree to permit (*e.g.*, the number, types, or locations of devices that could be deployed). The basis for this view is both the language of the Statements (which explicitly contemplates "creation" of "exotic" devices) and the negotiating record of the Treaty (which made clear that the parties intended deployment of "exotic" devices to be proscribed by Agreed Statement D).

Senator LEVIN. The second part of Agreed Statement D makes limitations on exotics "subject to discussion . . . and agreement." Under such provisions, any proposed limitations are *not* implemented *unless* there is an agreement between the parties. How, then, are there any limits in Agreed Statement D on exotics in the absence of any agreement on such limitations?

Judge SOFAER. The premise of this question is erroneous. The negotiating record makes clear that the parties intended Agreed Statement D to ban the deployment of "exotic" systems *unless* the parties agreed to allow deployment; an aspect of any such agreement would be approval of "specific limitations" on the systems.

Senator LEVIN. Does the term "ABM systems" in Agreed Statement G mean conventional systems or exotics? If the former, does that mean that we are free to provide other states technical descriptions, etc., relating to the construction of exotics?

Judge SOFAER. Agreed Statement G construes Article IX as obligating each party not "to provide to other States technical descriptions or blue prints specially worked out for the construction of ABM systems and their components limited by the Treaty." Pursuant to Presidential direction, the SDI program has been designed to be conducted in accordance with the "restrictive" interpretation of the Treaty. Under that interpretation, ABM systems or components based on other physical principles are "limited by the Treaty," and we are therefore constrained by Agreed Statement G in cooperative activities with our allies.

Senator LEVIN. Why did you discuss your interpretation with Ambassador Nitze and not with Messrs. Smith, Rhinelander and Garthoff?

Judge SOFAER. Unlike to other persons, Ambassador Nitze is an official of the U.S. Government and retains access to the classified negotiating record of the Treaty. My work on this subject, moreover, was done in close cooperation with Ambassador Nitze.

Senator LEVIN. Have you discussed your interpretation with General Palmer, who was the Acting Army Chief of Staff, and who was thus the ranking military official responsible for our ABM effort at that time?

Judge SOFAER. No.

Senator LEVIN. Was the administration's review of the ABM treaty, which led to the new interpretation, a result of questions which I asked of the Defense Department for the record on July 25, 1985? If not, what led to the review? When were you first aware Mr. Kunsburg of OSD was conducting a review of ABM obligations with respect to the development, testing and deployment of exotics? Was Mr. Kunsburg's review available to you? If so, please furnish me a copy.

Judge SOFAER. I do not know whether the administration's review of the ABM Treaty was a result of questions that you asked the Department of Defense. The factors that I do know led to the review were Soviet violations of the ABM Treaty, the implementation of our SDI program, and the ongoing arms negotiations at Geneva. I first learned of Philip Kunsburg's reported involvement in the Department of Defense's review of the ABM Treaty from a story in the Washington Post on October 22, 1985. Although I saw various materials prepared by the Office of the Secretary of Defense with respect to the proper interpretation of the ABM Treaty, I do not know which, if any, was prepared by Mr. Kunsburg. It would not be appropriate for me to supply the committee with materials prepared by another Department; that request should be addressed to the Department of Defense.

Senator LEVIN. What conventional systems, under your interpretation of the treaty, could as a practical matter be developed or deployed in a sea-based, air-based, space-based or mobile land-based mode, assuming there were no treaty prohibitions in these areas?

Judge SOFAER. I am not qualified to discuss the technological aspects of particular strategic defense systems.

Senator LEVIN. Why is the State Department recommending we follow the more restrictive definition when apparently it believes that the broader interpretation is the more reasonable one, and when the SDI Office says that the narrow interpretation will restrict their activities in a few years?

Judge SOFAER. The SDI research program has been structured, pursuant to Presidential directive, in a manner that can be accommodated within the confines of the "restrictive" interpretation. The President has determined that no need exists to alter that program.

Senator LEVIN. Does the Secretary of State accept the broader interpretation as the preferred interpretation, or does he merely say it is justified?

Judge **Sofaer**. The President has determined that the "broader" interpretation is "fully justified," and the Secretary of State concurs in that judgment.

Senator **Levin**. Have you reviewed the records of the Joint Chiefs of Staff relative to their understanding and actions concerning this issue?

Judge **Sofaer**. I have not made a special effort to review records in the possession of the Joint Chiefs of Staff, and I have not assumed that the JCS has any records that would be essential to a judgment in this matter and that are not contained in the depositories that I have examined.

Senator **Levin**. In your testimony, you said that the Treaty is ambiguous with respect to the development and testing of exotics. Article 13 of the Treaty requires ambiguities to be referred to the Standing Consultative Commission. Why has the State Department not taken this alleged ABM treaty ambiguity to the Standing Consultative Commission?

Judge **Sofaer**. This question contains several erroneous statements. I did not state in my testimony that the Treaty is ambiguous, but rather that the textual language is ambiguous, a term of art. That textual ambiguity necessitates reference to the negotiating record, which persuasively supports the "broader" interpretation.

Article XIII does not "requir[e] ambiguities to be referred" to the S.C.C. Rather, Article XIII(1)(a) states that the parties will use the S.C.C. to "consider questions concerning compliance with the obligations assumed and related situations which may be considered ambiguous." The "broader" interpretation does not raise such compliance questions, because the SDI program has been structured in a manner that can be accommodated within the confines of the "restrictive" interpretation.

Senator **Levin**. At the time of Mr. McFarlane's TV appearance of October 6, 1985, had the Secretary of State authorized the public release of the decision to adopt a broader interpretation of the ABM treaty? If not, how did the decision get released without the approval of the Secretary of State?

Judge **Sofaer**. I have no personal knowledge with respect to this question.

Senator **Levin**. Do you agree that the ABM Treaty would have to be amended before exotic systems could be deployed?

Judge **Sofaer**. Under the terms of the Treaty, the parties could deploy systems based on other physical principles if they agreed on "specific limitations" or invoked Article XV(2).

Senator **Levin**. Has the SDI Office expressed an opinion to you, or to anyone else in the State Department to your knowledge, relative to the desirability or advisability of a broader interpretation of the ABM treaty? If so, on what dates?

Judge **Sofaer**. No, never to me. I do not know the answer with respect to others in the State Department.

Senator **Levin**. General Palmer explicitly stated at a hearing in June, 1972 that "We can look at futuristic systems as long as they are fixed and land-based," and went on to say "The Chiefs were aware of that and had agreed to that and that was a fundamental part of the final agreement." Do you believe these statements are more significant than the inference you draw from General Palmer's earlier statement that "There is no limit . . . on R&D in the futuristic systems" which you think means whether or not these futuristic systems are fixed and land-based, especially since General Palmer later said: "The only system actually under development, in any meaningful sense, was a fixed, land-based system."

Judge **Sofaer**. All of General Palmer's statements are significant. Some of his comments do appear to support the so-called "restrictive" view of the Treaty's limitations. Other statements, however, could be read to support the "broader" view. It is therefore difficult to draw a definitive conclusion regarding General Palmer's view of the Treaty's regulation of future systems. The most important sources for determining the meaning of the Treaty are the textual language and the negotiating record, which support fully the "broader" interpretation.

Senator **Levin**. Please set forth all statements in the ratification history which explicitly state that exotics (other than fixed and land-based) can be developed and tested.

Judge **Sofaer**. My office has prepared an analysis of post-negotiation public statements regarding the Treaty's applicability to future systems. I provided this analysis to the committee in connection with my testimony.

Senator **Warner**. This hearing is adjourned.

[Whereupon, at 6:12 p.m., the subcommittee adjourned, subject to the call of the Chair.]

STRATEGIC DEFENSE INITIATIVE

TUESDAY, DECEMBER 3, 1985

U.S. SENATE,
SUBCOMMITTEE ON STRATEGIC AND
THEATER NUCLEAR FORCES,
COMMITTEE ON ARMED SERVICES,
Washington, DC.

TECHNICAL ISSUES

The subcommittee met, pursuant to notice, at 3:08 p.m., in room SR-222, Russell Senate Office Building, Senator John W. Warner (chairman) presiding.

Members present: Senators Warner, Thurmond, Cohen, Wilson, Nunn, Hart, and Exon.

Staff present: Alan R. Yuspeh, general counsel; Robert F. Bott, Douglas R. Graham, William E. Hoehn, Jr., and George K. Johnson, Jr., professional staff members; Colleen M. Getz and Russell C. Miller, research assistants; and Karen A. Love, staff assistant.

Also present: Romie L. Brownlee, assistant to Senator Warner; James M. Bodner, assistant to Senator Cohen; Mark J. Albrecht, assistant to Senator Wilson; Allan W. Cameron, assistant to Senator Denton; Janne E. Nolan, assistant to Senator Hart; Jeffrey B. Subko, assistant to Senator Exon; John B. Keeley, assistant to Senator Levin; and Gregory B. Craig, assistant to Senator Kennedy.

OPENING STATEMENT BY SENATOR JOHN W. WARNER, CHAIRMAN

Senator WARNER. The subcommittee convenes in open session this afternoon to continue to receive testimony on the President's Strategic Defense Initiative [SDI] Program. In this afternoon's hearing, which is the fifth in the series, we will hear the views of private witnesses on some of the vital technical issues related to the SDI program.

Our first witness this afternoon is Dr. Solomon J. Buchsbaum, the executive vice president for customer systems at AT&T Bell Laboratories. In addition to his distinguished career in private industry, Dr. Buchsbaum has served this country with distinction in a number of advisory capacities over the years.

For example, he has served on the Defense Science Board since 1972 and is now a senior consultant to that body, and he has been the chairman of the White House Science Council since 1982.

Dr. Buchsbaum, it is my pleasure to welcome you this afternoon on behalf of the subcommittee.

We are going to change one thing here. It was the intent of the Chair to have an additional witness on this first panel. However, due to scheduling difficulties, we were unable to do so. The Chair will continue to make every effort to ensure that all points of view are represented in these hearings.

Our second panel will focus specifically on the computer and battle management requirements associated with the SDI Program. Our witnesses are: Dr. Danny Cohen, the director of the systems division at the Information Sciences Institute of the University of Southern California; and Dr. David Parnas who is Landsdowne professor in the Department of Computer Science at the University of Victoria, British Columbia.

Thank you, Doctor, for a very long journey. Dr. Cohen is the chairman of the SDIO panel on computing in support of Battle Management [BM/C^3], commonly referred to as the Eastport Group. It was from this panel that Dr. Parnas resigned several months ago.

Both of our witnesses are recognized for their expertise in the areas of computers and computer software.

On behalf of the subcommittee, I would also like to welcome you gentlemen this afternoon.

Now we will hear from each witness and at the conclusion of all witnessses providing their direct testimony to the subcommittee, we will then engage in such questions as members of the subcommittee wish to propound.

Senator Hart.

Senator HART. Thank you, Mr. Chairman.

Mr. Chairman, I join you in welcoming these witnesses.

First, I want to stress that this subcommittee, indeed the entire Congress, is being asked to perform an extraordinary role here in interpreting the SDI. Most of us are not scientists or technicians. We are being asked to finance one of the most complex, if not the most complex, technical undertaking in the history of the human race.

As we struggle as nonexperts, nonscientists, to understand what it is we are supposed to be funding, it seems to me hearings such as this become increasingly critical. In particular those that are open to the public are important because it does give some members of the public and, through the press, others, an opportunity to engage with those of us who must make these policies or share in them, this process. This is a process of nonexperts making their way through a very dense forest, encountering all sorts of strange flora and fauna and trying to decide whether to continue through the forest and if so, in what direction and at what speed.

It is our hope that these witnesses, as well as others, will help us determine those questions.

I thank the Chair again for scheduling these hearings.

Senator WARNER. I thank the distinguished Senator for assisting in the arrangements for this panel.

Senator Thurmond.

Senator THURMOND. Mr. Chairman, I have no statement.

I want to say I am very pleased to be here at this hearing. I congratulate you on holding this hearing. I think it is a benefit to the public to understand more about this strategic defense initiative which the President has advocated and which I feel is very important to the security of this Nation.

Senator **Warner**. Thank you.

Senator Wilson.

Senator **Wilson**. Mr. Chairman, I will not take the time of the subcommittee.

I again commend you and Senator Hart on these important hearings.

Senator **Warner**. Thank you very much.

Now we will proceed to receive the direct testimony from each of the witnesses. Dr. Buchsbaum.

STATEMENT OF SOLOMON J. BUCHSBAUM, EXECUTIVE VICE PRESIDENT, CUSTOMER SYSTEMS, AT&T BELL LABORATORIES

Mr. **Buchsbaum**. Thank you very much Mr. Chairman.

With your permission, Mr. Chairman, I would like to submit my written testimony for the record. It is rather long. I do not propose to read it. If I may, I would like to summarize it. My summary will take about 10 minutes.

As you indicated, my name is Sol Buchsbaum. I am employed by AT&T Bell Laboratories [Bell Labs] as executive vice president, Customer Systems. AT&T, our parent company, does a lot of business with the Federal Government. The bulk of the business involves communications systems and services provided to both civilian and military agencies of the Federal Government.

Also included are specially designed systems for the Department of Defense, particularly the U.S Navy. Much of that business is supported by research and development done by Bell Labs, and the people doing that work report to me.

During the 1970's Bell Labs was the prime contractor for the Safeguard project. And perhaps it is worth mentioning that a decade earlier Bell Labs people, operating in Bellcomm, a company founded by AT&T to assist NASA, were responsible for the systems engineering of Project Apollo that put our men on the Moon.

Bell Labs has no contract with the Strategic Defense Initiative Organization [SDIO], but we do support one of SDIO's systems architecture contractors, as well as ballistic missile defense work for the Secretary of the Army.

However, my familiarity with the Strategic Defense Initiative [SDI] Program comes not so much through my work at Bell Labs as through three other activities of mine. I serve on General Abrahamson's strategic defense initiative advisory committee, which has been briefed in some detail on SDI projects and their management.

I chair the White House Science Council, which has also been interested in and exposed to SDI and its program.

And, lastly, I am now a senior consultant to the Defense Science Board, having once been its chairman.

During my years with the Defense Science Board, I was particularly interested in command and control. For example, a few years ago I chaired a Defense Science Board task force on Command and Control Systems Management.

In appearing before your subcommittee today, however, I do not represent or speak on behalf of any of these entities or bodies. I am testifying as an individual. The views I will present are those of Sol Buchsbaum, a citizen, hopefully an informed citizen.

Let me say at the outset that I recognize that the strategic defense initiative faces enormous challenges and problems which I do not minimize. However, a vision of the world in which the two superpowers have agreed to constrain their respective offensive nuclear forces to levels much lower than today's and, at the same time, have also agreed to protect themselves and their allies against nuclear attack with defensive systems—a protective shield—of reasonable effectiveness is an attractive one. Surely, that would be a more stable world than the one in which we live today.

Therefore, I believe it behooves the United States to do the research to determine whether or not we can develop the technology that such a protective shield would require.

No one can deny that this is a complex and difficult task. But I for one am heartened by the progress that General Abrahamson and his people are making. The President made his speech raising the possibility of such a defensive system in March 1983, less than 3 years ago.

The SDIO has been in business for only about 2 years. During that time, however, progress in its programs has been made in a number of areas and I discuss these further in my written statement.

I want to address particularly the challenges of integrating the various elements into a complete system whose parts work coherently to accomplish the SDI mission. A key function that must be considered from the very beginning in coming up with this integrated system is battle management and its associated command, control and communications, BM/C^3 for short.

Here I want to go into some detail because recently BM/C^3 has been raised as the area in which we face the greatest—some say impossible challenges.

The battle management/C^3 function is basically a problem of information movement and management—involving all SDI elements as well as key human decisionmakers.

The problem is not easy because of the vast quantities of information that must be obtained, processed, and synthesized throughout a large geographically distributed system, and done so quickly. Such a system, it has been estimated, would require tens of millions of lines of software. The issue of software complexity is compounded by the associated needs to test, simulate, modify, and evolve the Battle Management System.

Some critics have specifically questioned if it is possible to generate great quantities of error-free software for the system, and to ensure that it is, indeed, error-free software.

This is the wrong question. Designers of large real-time systems—systems that depend on complex software and hardware—know that it is impossible to generate great quantities of error-free software.

They also know that major problems in field use of software need not be associated with program bugs. Software is always part of a larger system that includes hardware, communications, data procedures, and people.

The right question, as well as the key issue, is the broader one of whether the total BM/C^3 system can be designed to be robust and resilient in a changing and error-prone environment.

The key, then, is not whether the software contains errors, but how the whole system compensates for such errors as well as for possible subsystem failures. The BM/C^3 system must operate continuously and reliably despite any errors or failures. Parts of the system must cover for each other to limit the effect of such problems—and they must do so quickly, typically in milliseconds or seconds.

Can such a large, robust, and resilient system be designed—and not only designed, but built, tested, deployed, operated, and further evolved and improved?

I believe the answer is yes. I seem confident of this answer because most, if not all, of the essential attributes of the BM/C^3 system have, I believe, been demonstrated in comparable terrestrial systems.

The system most applicable to the issue at hand is the U.S. Public Telecommunications Network, with which I am quite familiar. The network has attributes that are intrinsic to the BM/C^3 System as well.

These include the capabilities for continuous, reliable operation; for fault tolerance and overload control; for evolution in response to changing demands, functions, and advancing technology; for human control over key operations if and as required; for compatibility and interoperability among all systems; and for continuous testing, diagnosis, and maintenance—much of it by remote means.

I might say that this network today needs for its operation well over 40 million lines of software.

In other words, the telecommunications network has high reliability, availability, maintainability, and adaptability. And the network achieves these capabilities largely because it is a distributed system that uses redundancies and that uses well-specified, well-controlled interfaces in the coupling together of all component systems.

Now, let's imagine for a moment that the switching machines in the network are SDI battle stations; and that everything connected to the network, feeding information into it and requesting action—phones, data terminals, private branch exchanges [PBX's], and so forth—corresponds to SDI sensors.

Let's also imagine that the network signaling system that interconnects all switches is the nerve system, the backbone of the SDI communications system.

By the way, these switches, these battle stations, contain large computers. A typical switching system today operates with over 2 million lines of code. The total network needs over 40 million lines of code.

Some network battle stations, each with its own brain, are connected to others directly and some indirectly, but all are interconnected in a hierarchy. And these battle stations can communicate with one another, but not on an equal basis.

Some communications take priority over others in a prescribed way. Each battle station has a preassigned task—say, to attack and kill a predetermined set of targets. That task must be accomplished no matter what the workload presented to the battle station is.

So, overload control is an important attribute. We know how to do that. And total network is designed to accomplish its task no matter what happens. When there is a failure in some part of the network, some other part of the network takes over that task. So, it should be in an SDI system.

To back up my analogy of the network and SDI further, my written statement provides this committee with detail from lessons we have learned from helping to develop that network. This includes a discussion of the basic capabilities of high reliability and fault tolerance as well as high availability, maintainability, and adaptability.

I conclude this short summary by pointing out that these lessons learned are directly applicable to the major SDI challenges of battle management and associated command, control, and communications.

Mr. Chairman, I thank you for the opportunity to present my views on this very important topic.

[The prepared statement of Mr. Buchsbaum follows:]

PREPARED STATEMENT OF SOLOMON J. BUCHSBAUM, AT&T BELL LABORATORIES

My name is Sol Buchsbaum. I am employed by AT&T Bell Laboratories (Bell Labs) as Executive Vice President, Customer Systems. AT&T, our parent company, does a lot of business with the Federal Government. The bulk of the business involves communications systems and services provided to both civilian and military agencies of the Federal Government. Also included are specially designed systems for the Department of Defense, particularly the U.S. Navy. Much of that business is supported by research and development done by Bell Labs, and the people doing that work report to me.

During the 1970's Bell Labs was the prime contractor for the SAFEGUARD project. And perhaps it's worth mentioning that a decade earlier Bell Labs people, operating the Bellcomm, a company founded by AT&T to assist NASA, were responsible for the systems engineering of Project Apollo that put our men on the moon.

Bell Labs has no contract with the Strategic Defense Initiative Organization (SDIO), but we do support one of the SDIO's systems architecture contractors, as well as ballistic missile defense work for the Secretary of the Army.

However, my familiarity with the Strategic Defense Initiative (SDI) program comes not so much through my work at Bell Labs as through three other activities of mine. I serve on General Abrahamson's Strategic Defense Initiative Advisory Committee, which has been briefed in some detail on SDI projects and their management. I chair the White House Science Council, which has also been interested in and exposed to SDI and its programs. And lastly, I am now a senior consultant to the Defense Science Board, having once been its chairman.

During my years with the Defense Science Board, I was particularly interested in Command and Control. For example, a few years ago I chaired a Defense Science Board task force on Command and Control Systems Management.

In appearing before your subcommittee today, however, I do not represent or speak on behalf of any of these entities or bodies. I am testifying as an individual. The views I will present are those of Sol Buchsbaum, a citizen—hopefully an informed citizen.

Let me say at the outset that I recognize that the Strategic Defense Initiative faces enormous challenges and problems which I do not minimize. However, a vision of the world in which the two superpowers have agreed to constrain their respective offensive nuclear forces to levels much lower than today's and, at the same time, have also agreed to protect themselves and their allies against nuclear attack with defensive systems—a protective shield—of reasonable effectiveness is an attractive one. Surely, that would be a more stable world than the one in which we live today.

Therefore, I believe it behooves the United States to do the research to determine whether or not we can develop the technology that such a protective shield would require.

No one can deny that this is a complex and difficult task. But I for one am heartened by the progress that General Abrahamson and his people are making. The President made his speech raising the possibility of such a defensive system in March 1983, less than three years ago. The SDIO has been in business for only about two years. During that time, however, progress in its program has been made in a number of areas.

Advances have been made and are continuing in such key areas as sensors, defensive weapons, and space transport. And these advances are beginning to provide positive answers to questions that have been raised concerning the cost-effectiveness, survivability and robust performance of a multilayered defense system.

For example, in sensors advances have been made in the field of interactive discrimination, using directed energy—neutral particle beams or high power lasers—to allow the identification of nuclear weapons. These should help give us the capability to discriminate accurately real targets from a variety of decoys. Large optical sensors have been developed with "on chip" data processing capability reducing computerized loads on other system components. These electronic parts are radiation resistant. Also, cryocoolers have been developed that should increase sensor performance against targets and should help reduce system costs.

In the area of interception by defensive weapons we've seen some of the following accomplishments: Work has been done in atmospheric compensation that could allow ground-based high power beams to transit the atmosphere effectively. Lethality testing has shown that the Soviet's current boosters may be very soft, and the hardening of those boosters would impose a high economic cost on the Soviets. Also, free electron laser and high power optic advances are showing the way to build effective laser weapons. And finally, the development of kinetic kill concepts for midcourse allows for more cost-effective discrimination and interception.

I have just touched on the challenges of developing SDI elements such as sensors, target discriminators, and defensive weapons. Then there is the crowning challenge of integrating these elements into a complete system whose parts work coherently to accomplish SDI's mission. A key function that must be considered from the very beginning in coming up with this integrated system is battle management and its associated command, control, and communication—BM/C³ for short.

I want to address BM/C³ in some detail, because recently this has been raised as the area in which we ~~face the~~ greatest—some say impossible—challenges. In fact, some critics have tried to use this to build a case against the reliability, if not the viability, of an DSI system. I want to provide some opinions and evidence that I hope demonstrate this should not be the case.

The BM/C³ function is basically a problem of information movement and management—involving all SDI elements as well as key human decision makers. The problem is difficult because of the vast quantities of information that must be obtained, processed, and synthesized throughout a large, geographically distributed system—and done so quickly. Such a system, it has been estimated, would require ten's of millions of lines of software. And the issue of software complexity is compounded by the associated needs to test, simulate, modify, and evolve the BM/C³ system.

Some critics have specifically questioned if it is possible to generate great quantities of error-free software for the system, and to ensure that it is, indeed, error-free software.

This is the wrong question. Designers of large real-time systems—systems that depend on complex software and hardware—know that it is impossible to generate great quantities of error-free software. They also know that major problems in field use of software need not be associated with program bugs. Software is always part of a larger system that includes hardware, communications, data, procedures, and people.

The right question, as well as the key issue, is the broader one of whether the total BM/C³ system can be designed to be robust and resilient in a changing and error-prone environment. The key, then, is not whether the software contains errors, but how the whole system compensates for such errors as well as for possible subsystem failures. The BM/C³ system must operate continuously and reliably despite any errors or failures. Parts of the system must cover for each other to limit the effect of such problems—and they must do so quickly, typically in milliseconds or seconds.

Can such a large, robust, and resilient system be designed—and not only designed, but built, tested, deployed, operated and further evolved and improved? I believe the answer is yes. I seem confident of this answer because most if not all of the essential attributes of the BM/C^3 system have, I believe, been demonstrated in comparable terrestrial systems.

The system most applicable to the issue at hand is the U.S. Public Telecommunications Network. The network has attributes that are intrinsic to the BM/C^3 system as well. These include the capabilities for continuous, reliable operation; for fault tolerance and overload control; for evolution in response to changing demands, functions, and advancing technology; for human control if and as appropriate for compatibility and interoperability among all systems; and for continuous testing, diagnosis, and maintenance—much of it by remote means.

In other words, the telecommunications network has high reliability, availability, maintainability, and adaptability. And the network achieves these capabilities largely because it is a distributed system that uses redundancies and that uses well-specified, well-controlled interfaces in the coupling together of all component systems.

Now, let's imagine for a moment that the switches in the network are SDI battle stations; and that everything connected to the network—phones, data terminals, private branch exchanges (PBXs), etc.—corresponds to SDI sensors that feed information to the "battle stations" and cause them to take action.

Let's also imagine that the network signaling system that interconnects all switches is the nerve system, the backbone of the SDI communications system.

Some network "battle stations", each with its own "brain", are connected to others directly and some indirectly, but all are interconnected in a hierarchy. All these "battle stations" can communicate with one another, but not on an equal basis. Some communications take priority over others in a prescribed way. Each "battle station" has a preassigned task—say, to attack and kill a predetermined set of targets. That task must be accomplished no matter what the work load presented to the battle station is. So overload control is an important attribute. We know how to do that. And the total network is designed to accomplish its task no matter what happens. When there is a failure in some part of the network, some other part of the network takes over that task. So it should be in an SDI system.

In the telecommunications network, there are many "battle stations" or switches—20,000 local and nearly 1000 toll switches. And roughly 150 million "sensors" or telephones are connected to the network by 85 million access lines. Some network elements are enormously complex, highly reliable computers. For example, the 4 ESSth switching system, today's largest, can process and route over 700,000 calls per hour, and uses a program of about 1.3 million lines of code.

With this comparision between the telecommunications network and SDI in mind, let's examine the lessons we learned from helping to develop, test, deploy and operate the network. They suggest that there are three keys to achieving high reliability, availability, maintainability, and adaptability.

The first is the use of distributed architectures both for the entire network and for major systems within the network. This approach compartmentalizes crucial functions in modules throughout the country as well as within individual systems. And the approach also helps minimize software complexity, a constant concern in large-system design. Even though the total network requires over 40 million lines of software, for example, each component system requires no more than two million lines.

The second key is the use of redundancy, again both in the entire network and in the component systems. And the third key is the coupling together, the integration, of all the component systems by means of well-specified, well-controlled interfaces.

Let's examine in a bit more detail how the telecommunications network achieves its basic capabilities, with special focus on its approach to high reliability through tolerance to errors or failures.

For high reliability, the telecommunications network is built from highly reliable component systems. For example, the mean time between failures for a circuit pack is twenty years. Yet the network as a whole is much more reliable than its individual components. That's because the network is designed to be fault tolerant. It continuously and automatically checks its own condition. When a problem is detected, it isolates the faulty component, so that the network can continue to function using a substitute or redundant component. This strategy of isolating faults so that they do not propagate through the rest of a system is crucial to designing highly reliable systems such as the network. In contrast, the famous New York City blackout of 1965 illustrates how a single fault propagated through almost the entire Northeast power grid.

In the telecommunications network there is a layered approach to fault tolerance. At the highest layer, fault tolerance is designed in through network management. Consider what happens during a peak holiday calling period or a major network disruption such as a hurricane. Network managers can use available information and controls to make decisions about rerouting traffic in order to maximize network call-handling capacity despite abnormal conditions. In addition, vital classes of calls, such as police or hospital, can also be prioritized to get through.

The next layer of fault tolerance consists of automatic alternate routing of calls—done by a switching system if it detects some type of "traffic jam" along one possible route to a call's destination. For example, there are four different routes available today between Washington, D.C. and Los Angeles, and this will increase to fourteen by 1990.

At the next layer, fault tolerance is built in through the use of redundancy—such as dual processors in each switching system. This dual-processor architecture is designed not for load-sharing between processors, but for achieving high reliability. If a fault is detected in the first processor, control of the switch is automatically shifted to the second processor, to sustain continuous operation. The switch also automatically alerts a craft technician with information on the cause and location of the problem as well as its solution.

At an even lower level, fault tolerance is often built into a circuit pack itself, particularly if it includes a microprocessor. If a fault is detected, the microprocessor's software invokes fault recovery procedures to correct the problem or at least to prevent it from affecting a larger portion of the system.

For high availability, the public telecommunications network is designed to work at its specified level of performance even when some of its component elements are unavailable. As with fault tolerance, a layered approach is taken to achieving high availability. Redundancy is built in at many levels, and systems are designed to remain on-line even while undergoing maintenance and administrative operations. Individual network elements such as switching systems are also designed for high availability. The design goal for a central office switch is continuous, around-the-clock operation for 20 years or more—with no more than three minutes per year of downtime. This goal is usually met because of the reliable components and redundant architecture noted earlier.

The telecommunications network is also highly maintainable in order to meet the goals of high reliability and availability. Equipment is not only well-maintained, but also repaired or replaced quickly if it fails.

High maintainability is achieved through several interrelated ways. First, both systems and their component subsystems are designed to be highly modular so that faults can be isolated to a small portion of a system or a subsystem. Once isolated, faults can easily be fixed by replacing or repairing the small part—for instance, an insertable circuit pack. Second, systems are designed to include extensive maintenance diagnostics, through which a system continuously and automatically monitors its own overall condition as well as the condition of its component subsystems. And third, the collection and analysis of maintenance information are centralized even though network systems are distributed over a wide geographic area, many of them in unstaffed locations. Over 100 different large computer-based operations systems are vital to supporting such network needs as centrally administering and controlling maintenance for various types of systems. Moreover, network elements such as newer switching systems, to cite one example, are becoming increasingly sophisticated. So are their problems, which also tend to occur less often. Thus, technicians are less experienced and therefore less proficient in diagnosing and fixing them. These trends make it more and more important for maintenance functions to be automated. In fact, this is one of the areas in which expert software systems are being introduced most rapidly in the network.

Finally, the telecommunications network is highly adaptable on a variety of levels. The network adapts to the minute-by-minute changes in traffic conditions as well as to changing customer needs and to the evolution of technology, which may occur over months, years, and decades. Moreover, the network gracefully evolves each and every day, with new equipment being installed and with older equipment being reconfigured or removed. Through all this change, there is always interoperability among all systems and equipment, no matter what the vintage. The key to this is that adaptability is a network design requirement.

The distributed and highly modular architecture of the network increases its adaptability. Changes made to one network module have only a limited effect on the working of other modules. Different portions of the network must necessarilly affect each other, but great efforts are taken to control these interdependencies. Accordingly, the interfaces among the component systems of the network are carefully specified and controlled. While individual systems may evolve quite rapidly, the interfaces among systems are permitted to change much less quickly.

Another means for achieving high network adaptability is through the careful division of responsibility for decision making between mechanized systems and people.

Far too many choices are made too fast for network decision making to be left to people, but the possibility for human intervention is left open. Although mechanized systems make most of the decisions, these same systems also provide the information necessary for trained personnel to intervene. Because of the vast amounts of raw data available in a system as large and complex as the network, it is vital that information be reduced and focused to enable people to make reasoned choices.

In sum, we achieve high reliability, availability, maintainability, and adaptability in the telecommunications network through three key approaches: the use of distributed architectures, of redundancy, and of well-specified, well-controlled interfaces among all component systems. This approach not only reduces software complexity. It also permits the fullest use of software as a strength, enhancing network flexibility and resiliency.

The network lessons I cited are reinforced by the experience of AT&T and other large corporations in additional complex software and hardware systems. I am most familiar with AT&T examples, of course. And these range from SAFEGUARD, with its total software of over two million instructions, to 25 years and 25,000 miles of installed underwater sound detection systems which have never experienced a failure of any of the electronic components.

I conclude by pointing out that the lessons we learned from the development, systems integration, and evolution of the telecommunications network as well as from other complex projects should also apply to the major SDI challenges of battle management and command, control, and communications.

Thank you for the opportunity to present my views on this important subject.

Senator WARNER. Dr. Buchsbaum, that is a very encouraging point. We thank you.

Now we will have Dr. Cohen.

STATEMENT OF DANNY COHEN, DIRECTOR, SYSTEMS DIVISION, INFORMATION SCIENCES INSTITUTE, UNIVERSITY OF SOUTHERN CALIFORNIA

Mr. COHEN. Thank you, Mr. Chairman and members of the committee, for the opportunity to appear before you to discuss the software issues of SDI.

I am Danny Cohen from the Information Sciences Institute [ISI] of the University of Southern California. I received my B.S. in mathematics from Technion, the Israel Institute of Technology, and my Ph.D. in applied mathematics—computer science—from Harvard University.

I have been on the computer science faculties of Harvard and Caltech. I have been active in the computing field since 1962. My main research accomplishments are in computer communication and real-time systems.

I am also the chairman of the SDIO Panel on computing in support of Battle Management/C^3.

I would like to add that the views I express here are my personal ones and on behalf of most of the SDIO panel and not necessarily of the institute I am working for.

All the members of the panel were selected on the basis of their computing research or Battle Management/C^3 background. The panel focused its work on these technical issues. In addition to the discussions that the panel had, and to the presentations that were given to the panel, the panel also consulted several other computing experts.

It is my own judgment, and also that of the panel, that the computing requirements for the battle management of the strategic defense system can be met. This judgment is based upon the following reasons:

First, there is no fundamental principle that prevents meeting these requirements. I would like to emphasize this point because the SDI critics mislead the media, and the public, that there are fundamental mathematical problems that make it impossible to meet these requirements. In fact, there are no such scientific arguments.

Second, a system architecture may be devised for the strategic defense system to address its specific properties and exploit them. It should depend on loose, rather than tight, coupling of the various system components, such as sensors, battle managers, and weapons. It should not be a monolithic architecture, but one that depends on distributed decisionmaking by a multitude of battle groups. Such an architecture, is designed for evolution and change. It uses redundancy and diversity to achieve robustness.

Third, the software for such a system architecture is well within the reach of the current software technology.

I would like to add some background to this.

The architecture that we propose is designed for testability, both before and after deployment, based on the ability to infer the performance of the entire system from testing a small number of components.

In addition, the approach to the system architecture must be an open system, designed for constant evolution and diversity of both hardware and software.

A traditional philosophy held by some in the field of software engineering is the achievement of perfection. As important as perfection is, the ability to cope with imperfections is even more important. Such imperfections may appear in many levels, as a result of components failure, software errors, or even loss of components due to enemy actions.

Communication systems are implemented by their nature on a large number of independent processors, with diversity of hardware and software. They tend to exhibit these desired properties.

The components of those systems have enough knowledge to maintain a certain level of independence, such as to be able to generate alternatives and automatically reconfigure the flow of information, as needed for coping with unexpected losses of assets or communication links.

Typically, large software systems are built like chains that are as strong as their weakest link. In contrast, the strategic defense system has to be built like a network, stronger than any of its individual links.

The SDI must construct a system with such properties. These properties are not in common use today because of the larger expense associated with them. However, the SDI can, and should, afford this additional expense. One may even argue that the SDI cannot afford not to do so.

Therefore, it is possible to develop the software needed for the strategic defense system using today's technology and without depending on any major breakthroughs to occur in the software technology domain.

Since we have never implemented such a system before, a plan of action has to be devised. In January 1985 the President stated:

> The program is designed to answer a number of fundamental scientific and engineering questions that must be addressed before the promise of these new technologies can be fully assessed. The SDI research program will provide to a future President and a future Congress the technical knowledge necessary to support a decision in the early 1990s on whether to develop and deploy such advanced defensive systems.

That decision will be made by considering the technical parameters, as well as the political, economical, social, environmental, and any other aspects important at that time.

As you are aware, there is some public opposition to SDI. Such objections are based on a variety of reasons such as political—it is undesirable, it is destabilizing, it would escalate the arms race; economical—it costs too much; social—there are better things for scientists to do, and other. Undoubtedly, the soundest reason would be the technical one—it cannot be done.

We, as a panel, are interested only in the technical aspects.

Please notice that the earlier arguments that, "You cannot hit a bullet with a bullet" lost their popularity after the successful demonstration of just that. Technical arguments about the limitations of the other weapons, for example, lasers, and sensors are as unpopular. By an elimination process the battle management software is now the focus of the technical argument against SDI.

This argument evolves around the theme that the software will never work because writing 10 million lines of error-free code is impossible and even if this were accomplished, its correctness could not be mathematically proven; and even if this were accomplished, it only proves the adherence of the code to the specifications and not the validity of the specifications. Therefore, the software would never be trustworthy.

This argument gained a great deal of attention, fueled by a generous boost from a cooperating media. The Washington Post had a front page major headline "Computer Bugs Seen as Fatal Flaw in Star Wars," designed to coincide with a hearing of this committee. This story, which was also repeated on the following weekend under the heading "The Software Is Too Hard," emphasizes the con side of the story, and downplaying the pro side.

The New York Times shows a similar bias. For example, a July 4, 1985, story miscited a Bell Laboratory survey to discover an average of 300 serious errors in every 1,000 lines of code. Such a discovery is obviously a newsworthy story. By now the reporter knows that the number in that report is only 0.5 to 3 errors, not 300, per 1,000 lines. However, correcting this sensational statistic is not as newsworthy as the original misreporting.

The story failed to mention that for programs that are considered tremendously critical and enough resources are allocated to assure their quality, the number of errors is lower than 0.1 per 1,000 lines, and even smaller for system-critical errors.

Many who have technical arguments against the feasibility of the software mislead the public and the media by claiming that there exist scientific arguments and fundamental mathematical problems that make this software task infeasible, just as there are fundamental principles that contradict perpetual motion.

In fact, there is no fundamental scientific argument that it is not possible to construct the software for the Battle Management of the strategic defense system. On the positive side, one can prove the existence of such a system by showing that one can construct it.

We do not expect any breakthroughs in software productivity to occur soon. The rate of its improvement—more than 7 years to double—is pathetic compared with progress in computing hardware—1 to 2 years to double.

Even under the conservative assumption that by the time the system is deployed—10 years?—the state of software production will be as it is now, it is our judgment that the software can still be constructed to perform the job.

To achieve this we should not look for help from the institutionalized and stagnant subculture of the software engineering establishment that try to mimic mathematics at any cost, even if it means sacrificing functionality and relevance. This sect grossly overrates the perfection of Swiss clockwork and strives to achieve it.

We should instead make the software incorporate many of the concepts proven in communication systems. I mean both telephone and computer communications networks. The communication approach copies with imperfections and corrects for them, rather than attempting to achieve an unattainable perfection.

It is designed for evolution, for diversity and for open system interconnection. It is based on precise layered protocols for cooperation among loosely coupled processors. By following this approach and by exploiting redundancy based on diversity; that SDIO can and should afford, we can construct a sturdy software network rather than the traditional linear software chains which are only as strong as their weakest link.

This communication approach achieves a high level of robustness, not only by redundancy and diversity, but also by the ability of the distributed units to create alternatives to circumvent loss of units and of communication channels. In traditional software, loss of resources is the exception; in the communication world, it is the rule.

Professor Parnas, in his celebrated attack on the feasibility of the SDI software said:

> The goals stated for the strategic defense system cannot be attained by the class of systems that you are considering.

He, like many of the critics, fails to understand that SDIO is not yet considering any particular class of systems. Rather, the choice of the class of system is a major architectural task.

When we pointed this out, the critics claim that we changed the requirements laid down by the President in the March 23, 1983, speech, which is like the way architects are given a task—"We need a house for a family of four." Obviously, this speech is not meant to be a precise specification and requirements document without which no contractor can deliver a system.

The critics blame us for modifying the requirements until we find something that we can solve. Indeed, the first step toward fulfilling the scientific and engineering mission of SDI is to find out the technical specifications of the system required to "make ballistic missiles impotent and obsolete" and then to study its parameters.

The results of the scientific and engineering efforts of SDIO will show the expected level of effectiveness and confidence of the anticipated system. These parameters will be taken into account when the future President and a future Congress decide about deployment.

In a letter to the SDIO director, Professor Parnas suggested consulting the highly accomplished software expert, Prof. Fredrick Brooks. On October 30, 1985, Dr. Brooks testified before this committee:

> I see no reason why I or any other competent, experienced, better software manager than I am—and there are a lot of them—could not undertake to build such a system.

In the same letter Professor Parnas suggested to "consider his, Brooks', opinions with an open mind." the critics should do likewise.

There are those who claim that they cannot produce adequate software. We agree that they cannot. There are experts who claim that they can. We agree with them, too.

Again, I thank you for the opportunity to share with you my opinions regarding the software issues of SDI and I welcome your questions.

Senator WARNER. Thank you very much, Dr. Cohen. That is an encouraging report and unequivocal.

Gentlemen, for the benefit of those members of the subcommittee who have joined us, Senator Hart and I thought that the most comprehensive and valuable approach could be achieved if each of the witnesses provided their direct testimony and then we will enter into our customary round of questions, 5 minutes per member for the first round.

We will now hear from Dr. Parnas.

STATEMENT OF DAVID PARNAS, LANSDOWNE PROFESSOR, DEPARTMENT OF COMPUTER SCIENCE, UNIVERSITY OF VICTORIA, BRITISH COLUMBIA

Mr. PARNAS. I would like to thank you for inviting me here today and giving me a chance to testify about something which I think is very important to the defense of this country. I am going to try——

Senator WARNER. If I may interrupt, we are at the moment without the benefit of your charts. On the assumption that they will be of value to us, we had better figure out a way that they can be followed by members of the subcommittee.

Mr. PARNAS. May I point out that you do have copies of this chart.

Senator WARNER. Well, that is helpful. Let us all orient ourselves a minute here.

Gentlemen, I am told the charts that will be displayed are appended to the documents before us bearing the name of our witness, Dr. Parnas. I imagine the charts which are very clearly provided in your testimony will be adequate for the members of the subcommittee.

Gentlemen, do you share this view?

Mr. PARNAS. Then I would like to leave the charts for the people in back and continue to talk, assuming you can see the ones on your own copy.

Senator EXON. I will say for the witness' information, I assume this briefing is for the members of the subcommittee.

Senator WARNER. Yes. It is an open and public meeting.

Senator EXON. Could we possibly get it up here then so that everyone can see it?

Senator WARNER. My suggestion is that we proceed, gentlemen, using the written material provided by Dr. Parnas and we discontinue the charts.

We are going to have order in this hearing. I suggest we turn off the screen. You proceed and use the material that is provided, Doctor. It is very definitely prepared for the subcommittee by yourself. We are ready to receive your testimony.

Mr. PARNAS. In my first chart I wanted to introduce myself and explain I am a U.S. citizen speaking as a private person, that I have a Ph.D. in electrical engineering, systems and communication, in 1965 from Carnegie Mellon University and I have been producing software products, things that have been used by other people since 1962.

I am currently professor at the University of Victoria. I am also a part-time computer scientist at the U.S. Naval Research Laboratory. I am consultant for several leading military defense contractors, including, I think, all of the SDI contractors.

I have had papers that are considered groundbreaking papers in a number of areas including:

Design languages and automatic computer design.

Use of simulation in designing hardware and software.

Modular programming—organization of large programs.

Hierarchical structures in programs.

Precise specifications of software interfaces.

Decentralized real-time system design.

Requirements documents for real-time software.

Mathematical semantics of nondeterministic programs.

More than 90 papers.

There are two points I would like you to understand about these things.

First of all, many of the ideas that the SDIO panel is saying that they are going to be using, the new systems or ideas, I am one of the earliest proponents of and I teach in my classes.

The second is, I devoted a fair amount of my life to making positive contributions to the defense of this country in the form of improving the quality of military software and I believe I am making a positive contribution today even though I am taking a negative position.

Senator WARNER. Doctor, we respect your views and your backgound qualifies you eminently to provide this subcommittee and the Senate expert opinion on this program.

Mr. PARNAS. What I would like to explain is how I came to the conclusion that SDIO is, in my opinion, dangerous for this country to undertake. I take as my requirement the statement by President Reagan in 1983, which I wholly support, that he wants us to make nuclear weapons impotent and obsolete.

There are a number of things that have to be done for that purpose. The most important thing for the subcommittee to understand today is that none of these things can be done without software. Software has to process the data collected by the sensors and use it to make decisions and aim the weapons. Software will be the glue that holds the whole system together.

The point that I think is really important to remember is that if we can gain the things that I would like to see us gain from a project of this kind, the thing that President Reagan promised, that it is very important that we trust that software. If we do not trust the software, if we do not trust the system, we will make decisions as if it were not there, continue the deterrent with both a shield and missile-building program.

They will have to assume that the shield might work and redouble their efforts. Now, one of the things that I would really like to impress on you is that I do not expect the SDI software to be perfect. I have been working with real software all my life.

I drive a car every day that I trust and I know it is not perfect. I just want it to be trustworthy. What I want to know is what its limits are, when it can succeed, and when it can fail. I want to have confidence it will not fail catastrophically.

I have never in any argument or in my professional life demanded perfection in any product including software. I began my professional life as an engineer. I have been taught that engineers make mistakes and there are three ways we can produce reliable systems. There are ways of validating the designs that our intuition comes up with.

The three ways are mathematical analysis, exhaustive case analysis, a very prolonged, very realistic testing of the complete system.

What I would like to convince you of is that none of those things is possible for software. It turns out that we have lots of emperical evidence that software is the last part of any military or nonmilitary system to be ready. The reason is that we do not have any of those three validation methods.

The mathematical tools that we have are designed for something called continuous functions, and do not apply well to software. All proofs of correctness of programs make approximations that are not valid for this kind of software, especially the numerical calculations.

The exhaustive case analysis that we use when we do not have mathematical tools is often not available to us because there are too many cases. It is easy to come up with statistical calculations that show that thorough testing to instill real confidence that catastrophic failures will not occur can require thousands of years.

Software systems are never reliable when first put into use, their reliability increases after use, but you never really know that you have found the last bug.

I was told the other day a story about a bug in a telephone system that caused a switch to fail for nearly 2 hours. It was supposed to be down 2 hours in 40 years, but it failed in the first 2 years of use. It was a bug that turned out to have been in there for the whole 2 years.

That kind of argument may sound as if we could never build trustworthy software and that is not the case. There are a number of reasons why you can build it and here is the general quality they all have.

The requirement sometimes allows it to be untrustworthy. For example, a telephone system. No one objects when a call occasionally gets lost. They only consider the system to be down if all calls cannot get through for an appreciable period of time.

There has been extensive use under actual conditions before final deployment of the software. I have worked as a consultant for AT&T Bell Labs and I know that before anything is put into permanent use, they go through a period called a "soak" in which they test the software with real data in the real world connected to real equipment.

Another very important thing is that the operating conditions of the software have to be controlled and predictable. The telephone system is very, very careful to make sure you cannot connect faulty equipment. There are all kinds of detailed standards to control that.

The hardware reliability is assured through redundancy and through knowing that coordinated failures are very, very unlikely. Backup manual systems are available in many cases when needed or people just wait a little while. That kind of thing happens with the shuttle. It happens with the telephone network.

Unfortunately, none of those things hold for SDI.

Now, there are more things that make SDI much more difficult than other projects.

First of all, we do not know exactly what the job is and we cannot know the mathematical functions that are required of the software because they are controlled by the other side, by the Russians. It is possible for them to change the problem and us not know it, so we can never be sure that we have met the requirements; we can never be sure that we know what the exact requirements are.

Space based ABM systems have distributed computing like the telephone company, but because the thing is in space and subject to coordinated attack by sophisticated attackers, both the channel and hardware are going to be unreliable.

The telephone network has physical distribution of data, but it does not have to be redundant and consistent in real time or even close to it. We know from military systems that have tried to do distributed data that sometimes we can have battle alerts because we think there are more ships around than there are because the data base gets out of date and inconsistent.

Redundancy, which is the key to reliability, is, first of all, unusually expensive in space.

Second, redundancy works when you are worried about independent failures of components, for example, a manufacturing problem. Redundancy does not work when you have to worry about design failures because design failures may be in the redundant code itself. It does not give you the kind of assurance in software that it does in hardware because all software errors are design errors.

It turns out if you look closely at how these military systems are done, including the A-7 software with which I am now intimately familiar, you find they are based on assumptions about how the software is going to be used. There are real time schedules built into it.

Unfortunately, that makes them subject to overloading, in a very simple way, by an enemy that has any inkling as to what kind of schedules are built into it.

A really critical factor is that there are very limited opportunities for realistic testing of the whole system.

All of the networks of which you will hear and all of the successful software of which you will hear, could be tested because of the fact that most of the components are controlled by us, we have been able to simulate them during testing. However, we know that after we do component testing and simulations and we put a system out in the field, it invariably fails because something comes up that we did not anticipate.

That kind of thing, for example, leads airplanes to crash even though the software tested out all right in the preflight test. There may be interaction between hardware and software that was not anticipated.

Finally, this software is only going to be used once and for a short period of time, if it is ever to be used at all.

I have been inside of trucks that have software computers that served in Vietnam. All over the walls were "debugging notes." The manufacturers had to put two civilian programmers in the field in Vietnam in order to correct the programs because they could not find all the bugs at home in the laboratory and test it. We would not have that kind of opportunity with SDI.

It is often said that this system is going to be the largest real-time system ever made. None of my arguments are based on those estimates. They are based on the fact we cannot know the requirements that we assume are correct.

Now, it is often said these arguments would apply to other military softwear. I have given you a list of technical differences and they are very important technical differences.

I can give you a list of nontechnical differences as well. This is an all-in-one basket proposal, all eggs in one basket. If we really follow the reasoning of President Reagan, then we would end up saying we are depending on this completely and that is different. In all cases we use redundant weapons and techniques.

SDI is different because it will only be used once. All the military software we now find reliable has been used several times and we have gotten the bugs out of it that way.

SDI is different because we cannot test it under real battle conditions and because we have never had this kind of distributed system and because in this particular weapon system the software is so vital it plays a more vital role than software any other weapon system we have successfully built.

Finally, SDI is different because our enemy will be forced to focus so much attention on it.

One of the things that scares me if this system, and one of the reasons I believe in the long run no one will ever trust this system is because it will be extremely subject to a kind of blackmail.

One of the things we know from game playing experiments with computers is if you know the program of the other computer, you can always beat it. Even as a mere human being, if you know the program you are playing against, you can usually beat the computer unless the game is a very, unfair game.

What will happen in this defense system, and it has happened with radar systems, it is documented in the DARPA report recently, if you know a program, get a copy of it, you can plan countermeasures and attack with confidence and safety.

One of my nightmares about this system is one day we will get a truckload of computer listings from the Russian Embassy with notes all over it, notes which show they have found a countermeasure, they have found a flaw in the algorithm, and there will be a list of demands and we will be completely open to that kind of blackmail.

It is my feeling that we cannot afford to depend on a defensive system in this way because of this risk. Software is too easily countered and too easily communicated.

After I made my decision to resign and communicated it to the SDIO, I waited to see a serious rebuttal. I want to say that I have heard one yet I have not heard one to this day. I have heard people say, "Of course we cannot have perfection, but I am not demanding perfection."

I have heard people say SDI is only a research project, new breakthroughs may be found. We won't find one if we cannot refute the critics.

Now, it is absolutely true that we might find some way to build this thing so that it would be right the first time we used it. However, it is equally true, I believe, that we could have 10,000 monkeys typing for 5 years and they would recreate the Encyclopedia Britannica. Neither is impossible, both are highly unlikely.

We have a big advantage with the encyclopedia. We can check to see if it is right or not. We can check the copy. We do not have corresponding verification technology for the SDI software.

Other statements that I have heard people say is that we could have an extensive testing program. We have both mathematical and empirical evidence that testing does not show all the bugs. It only shows you have not found any of them up to now. I am claiming we will never be able to know that the software will function as required.

One of the responses to this criticism by the panel is that I was criticizing the centralized architecture in the Fletcher report, I was looking at a certain class of system. I did not pay much attention to that aspect of the Fletcher report because I recognized the same problems the panel did.

Instead I am talking about space-based systems, distributed computing, with computers in space, sensors in one place, weapons in another place. That is very, very intrinsic to this problem and all these systems are going to have these properties. Nothing in my argument assumes a centralized design.

One of the things I think is being propagated, and I do not understand why, is a myth about decentralization. One of the things I was told is that SDI had already decided it was OK, they would not have to build 10 million lines of code, they would only have to build 10 1 million lines of code by using decentralization.

Even 10,000 lines of program have the kind of problems we know about and cannot be trusted without thorough testing in the field.

Then there is a myth that says we can make SDI a set of totally independent battle stations. Physical layout of the problem does not allow them to be independent. We cannot assume that the sensors that will first get information about a missile and its warheads will be on the same satellite and same battle station that has to shoot them down. Things are moving too fast up there.

A more basic computer science kind of myth says if you have communicating sets of teams in software, you cannot have catastrophic global failures. We have had failure even in communications networks which have only a subset of problems we are talking about today. There have been global failures caused by individual component failures.

A number of years ago, the ARPANET, of which Dr. Cohen is so proud, came to a complete halt because of one failure of one component in generating messages. I use networks all the time. They occasionally come to a halt because a failure in one of the components generates so many messages, it blocks the others.

When you think of a driving system when you go home after this meeting, you will know even though each of the vehicles is independently controlled, you can still have traffic jams that cause all of them to fail.

Decentralization does not do it. In fact, theoretical results show that decentralized networks with communication between the components are mathematically equivalent to another centralized network and can have the same problem.

Moreover, the practical experience that I have gained in my years of working with these systems and with the software cost production project that I am leading for the U.S. Navy has shown me that these bugs are much harder to find than they would be in a centralized system, partly because nobody understands the whole thing and everybody has to understand the interface perfectly.

Now, we have been told, and I have read several times, there is no fundamental law of computer science that says SDI cannot work correctly when needed. That is true, I never said there was.

What I did say is that there are fundamental reasons why we are unlikely to have software that works correctly when really needed and that is because of (1) our inability to know exactly what it is supposed to do and (2) to validate that it does do what we think it does.

That means that we cannot trust it. We cannot trust it because we do not know whether it will be correct or not. Not that it will be perfect, but rather it will be free of catastrophic failure.

This is especially true because it is going to be operating against an enemy who will not attack unless he thinks he has found a countermeasure. We will have to be very, very sure that there was not one that he could find.

I guess the important thing to understand about this is that these are not limits on computers. There are limits on what human beings can do. There is no fear that computers cannot do this, but we have, through the use of information theory, theorems that show the amount of information we have to understand, to be sure that the system will work when needed is so vast that we cannot do it. That is why program verification does not work and I believe never will work.

Now, there is one last set of things that I find people referring to. People always say that the opponents of SDI are politically motivated. I know personally that I am not. I know personally that many SDI proponents are.

I find that the supporters of SDI often say even though it is not trustworthy, we ought to go ahead because research will be good for the country. I believe that is not true. In fact, I think it will be dangerous for the country.

Even though this is not a computer science thing, I would like to take 30 seconds to explain.

We have a limited pool of talent in this world. I know as a teacher that it is very hard to get very good people. There are some very real problems that I would like to be solved by the computer science community in the military software.

One very simple way is improve air/land coordination for conventional weapons which I think is very important for our security which I think is very badly needed. I do not want to see the great talents that I see going into SDI going into something that we cannot trust. I want to see it going into very ambitious but possible projects such as air/land coordination using computers which has some of the problems of SDI, but not all of them which I believe we can document.

The second reason I do not think it is a good idea, I have spent 20 years of interaction with the Defense Department watching research projects. I believe that program oriented research is very ineffective. You get far fewer results for your dollar because people end up funding those projects that make the biggest promises instead of those with the most merit.

Finally, I believe that if we continue this project, our strategic position will be weakened, because the measures I would expect the U.S.S.R. to take on, to take account of it, will be valuable to it even if we find out that this system, like the Safeguard system, was unusable and unreliable.

We would end up shutting down our system as we did Safeguard and find them with an overwhelming number of missiles. I think that would be a disaster for this country and I am frightened of it.

Thank you very much.

[The statement of Mr. Parnas follows:]

Software and SDI

David Lorge Parnas
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Who am I and what will I discuss?

I am a computer scientist specializing in software engineering, and professor at University of Victoria. I have published more than 90 papers on computer system design, quite a few of them widely cited and reprinted. I have 25 years of software construction experience including 14 years of experience as a consultant for DoD and DoD contractors. My work on large scale programming, hierarchical organizations, simulation, and cooperating sequential processes has influenced many DoD efforts. I was appointed by the Strategic Defense Initiative Organization (SDIO) to serve on a panel advising them on computing research in support of battle management. I resigned because I believe that (1) no system of the sort being considered by SDIO can ever be trusted and (2) investing effort in a defense system that we cannot trust is not in the country's interest.

Why is it important that a system to meet President Reagan's goals be trustworthy?

If SDI is untrustworthy, it will not allow us to abandon deterrence. The USSR, seeing both a "shield" and missiles would feel impelled to build additional, compensatory, weapons. If we waste our effort on a system we can never trust, while they put their effort into weapons to overcome it, our relative position will deteriorate.

Why does SDI depend on software?

The "business ends" of SDI comprise a variety of sensors and weapons. The sensors will produce vast amounts of raw data that computers must process and analyze to direct the weapons. Computers must detect missile firings, determine the source of the attack, and compute the attacking trajectories. Computers must discriminate between threatening warheads and objects designed to confuse our defense. Computers will aim and fire the weapons. Software, which controls the computers, is the glue that holds such systems together.

Why is software always a weak link in digital systems?

When engineering products are reliable, it is because of verification by some combination of: (a) mathematical analysis (b) exhaustive case analysis, or (c) prolonged testing of the complete product. Without such validation, we cannot trust the product.

a. Our most practical mathematical tools are useful for systems that can be described by continuous functions. Continuity allows easily manipulated representation of functions and simplifies analysis. Software, a discrete state system, cannot be described by such functions. The best tools for mathematical verification of software only work on small programs and make approximations that can hide serious errors. Simple information theoretic arguments suggest that we cannot expect major improvements in these tools.

b. Exhaustive case analysis, can only be used when the number of cases is small, or the product has a highly repetitive structure. Software has a huge number of states and no regularity.

c. The number of input conditions and internal states for real software systems is so large that thorough testing is never possible. "Testing can show the presence of bugs, never their absence" (E. W. Dijkstra).

Such theoretical observations are confirmed by practical experience. We can build adequately reliable software systems, but they become reliable only after extensive use in the field. Although responsible developers perform many tests, including simulations, before releasing their software, serious problems always remain. No experienced person trusts a software system when first deployed. Theory tells us that this is not the result of carelessness or inexperience. We can improve the quality of our work, but early deployment problems with software will not go away. We will never know when we have found the last serious bug.

Why is SDI software much more difficult than other software systems?

a. SDI software must be based on assumptions about target and decoy characteristics, which are controlled by the opponent. We cannot rely upon our information about them. The dependence of any program on those assumptions is a rich source of effective countermeasures. Espionage could render the whole multi-billion dollar system worthless without our knowledge.

b. In space, the redundancy required for high reliability is unusually expensive. The dependence of SDI on communicating computers in space, makes it unusually vulnerable. High reliability can be achieved only if failures of individual components are statistically independent; for a system subject to coordinated attacks, that is not true.

c. Programs that reliably meet strict real-time deadlines are based on built-in schedules, computed in advance. For SDI, schedules must be based on assumptions about the structure of an attack. Those assumptions allow countermeasures that will overload the system - causing it to either fail completely or ignore some of the objects it is tracking. Because every computer system has finite limits, overloading is always available as a countermeasure.

d. Realistic testing of the integrated hardware and software is impossible. Many potential problems would not be revealed by component testing, simulations, or small scale field tests.

e. Unlike other weapon systems, there will be no opportunity to modify the software during or after its first battle. It must work the first time.

These five properties are not shared by other large software projects. They are inherent in the problem, not a particular system design. They cannot be evaded by proposing new system architectures.

My Conclusions

SDI software that is correct the first time that it is really used is not impossible; it is also possible that 10,000 monkeys could reproduce the Encyclopedia Britannica. Both are highly unlikely. However, although we could verify the correctness of the encyclopedia, we could not verify the SDI software. We would never dare to trust it. President Reagan's goals are the right goals, but the SDIO approach will never achieve them.

What about the counter-arguments?

Most of the arguments that SDI software can succeed, do not respond to either the theoretical or the empirical aspects of my argument. For example, they state, correctly, that effective SDI software is not impossible, but do not explain how we could gain confidence in it. They propose vague "new" architectures, but do not show how those architectures overcome my arguments. Below are the counter arguments of which I am aware. My phrasing of those counter arguments is enclosed in quotes and is followed by my response.

a) *"SDI is still a research project - new breakthroughs may be found."*

These difficulties are very fundamental. The breakthrough required is a revolution in mathematics. SDI is not sponsoring such work and no such miracle is likely.

b) *"We can't know that we can't do it until we try."*

Both theoretical arguments and overwhelming empirical evidence tell us that we can't do it. No attempt should proceed unless errors in these arguments can be found. Forging ahead, without a convincing refutation, is doomed to failure.

c) *"An extensive testing program will overcome these problems."*

All empirical and theoretical evidence says it will not. Testing sufficient to give us confidence that there are no catastrophic errors would take prohibitively long.

d) *"Automatic Programming will solve the problem."*

Automatic Programming is just programming in a different language. It overcomes none of these problems.

e) *"Artificial Intelligence will solve the problem."*

Most "AI" programs are less reliable and harder to verify than standard programs.

f) *"New software engineering techniques will increase reliability."*

Yes, but not enough to overcome the fundamental problems described above.

g) *"Decentralized Architectures will not have these problems."*

Neither my arguments nor those of the many other computer scientists that criticize the project are tied to a particular architecture. Unless the components of a decentralized system are completely isolated, every decentralized system is mathematically equivalent to a centralized system. Experience with such systems shows that they can have the same global problems as centralized ones. In fact, errors in decentralized systems can be harder to find than errors in their centralized equivalents.

It would not be practical to build SDI with completely isolated components. Even, if we could, individual components would be subject to the same difficulties.

h) *"Those who claim SDI cannot be built are politically motivated."*

I know of no political reason to be against a shield that would protect us and the USSR from Nuclear Weapons. Any possible political objection to a shield was removed when President Reagan offered to share the technology. The only reason to oppose SDI is a belief that it will not achieve what President Reagan wants it to achieve.

In contrast, there are many extra scientific reasons for supporting SDI - even if the project is doomed to fail. I have read public statements by supporters saying that the project should be carried out for economic or political reasons, not military ones.

Am I alone in these opinions?

A number of highly respected computing researchers have communicated support for my position. Many people have voiced doubt about the software before I did. I am merely the first person working for SDI to quit for these reasons. Others refused to work on the system in the first place.

When I communicated my ideas and conclusions to people in the military software community, no one argued with my technical conclusions. Instead, they argued that the money was there and we should try to spend it for useful research. That view is very widespread.

Many have told me privately that they agree with me but fear for their jobs keeps them from speaking out.

Will there be other benefits that justify participation even though a defensive shield cannot be built?

Many proponents of the system argue that there will be benefits to the research program even if it does not lead to a defense against missiles. I am sure that among the many projects being supported by SDIO, there are some with real scientific merit. However, in my 20 years of experience with DoD research, I have found such programs to be very inefficient. Research is often supported because a proposal makes grandiose claims, not because there is real scientific merit in the approach. DoD often overfunds research and produces low quality results. As Makowski has said, "Overfunded research is like heroin: it leads to addiction, weakens the mind, and furthers prostitution." In my own field, the best research and the best development happens in the commercial field and, to a lesser extent in academia; it is not DoD funded industrial work.

The U.S. would be using its military budget, and its scientific talent, more wisely if it abandoned the delusion that reliable space based anti-missile defense is achievable. There are many useful ways that technology could be used to increase the efficiency of our military forces. We will make more progress with ambitious but realistic goals.

Am I demanding perfection of SDI software?

There is a vast difference between trustworthiness and perfection. My car is far from perfect, but I trust it to do its job. We do not demand perfection, merely a high probability that the product is free from catastrophic defects. There are many military software applications where we can achieve such confidence. Space based missile defense is not one of them.

"The Requirements of a Strategic Defence System"

In March of 1983, U.S. President Reagan said,

> "I call upon the scientific community, who gave us nuclear weapons, to turn their great talents to the cause of mankind and world peace; to give us the means of rendering these nuclear weapons *impotent and obsolete.*"

To satisfy this request the software must perform the following functions:

- Rapid and reliable warning of attack, detecting an attack and defining its location, determining likely target areas for confident initiation of the battle, determining track data
- Efficient intercept of the booster and post boost vehicle, allocation of individual targets to weapons, weapons control, birth-to-death tracking of targets
- Efficient discrimination, in the post-boost and midcourse phase, of decoys from warheads, continued tracking using data from earlier phases
- Interception in midcourse and terminal phase, allocation of targets to other sensors and weapons,
- Kill assessment, evaluation of the effectiveness of previous phases, to guide future resource allocations.

It must be constructed in such a way that all parties are confident that it will perform these functions when called upon to do so.

Why is it important that the software can never be trusted?

- "We" will make decisions as if it was not there.
- "They" will make decisions as if it might work.

How good must SDI be?

It need not be perfect.

It must be trustworthy.

We need to know its limits.

We need confidence that it will not fail catastrophically.

A necessary condition for trustworthy engineering products is validation by:

- Mathematical analysis, or
- Exhaustive case analysis, or
- Prolonged, realistic, testing

or a combination of the above.

The system must be operated under controlled or predictable conditions.

Why software is always the unreliable glue in engineered systems

- The best mathematical tools require that a system be described by continuous functions.
- Exhaustive case analysis can only be used when the number of states is small or the design exhibits a repetitive structure.
- Thorough testing of real software can require thousands of years.

Consequences: software systems are never reliable when first put in use. Their reliability increases after use, but one never knows when the last important bug has been removed.

Why is it that we have some usable software now?

- Sometimes the requirements allow untrustworthy software
- There has been extensive use under actual conditions
- Operating conditions are controlled or predictable
- Hardware reliability assured through redundancy
- "Backup" manual systems available when needed

What makes the SDI software much more difficult than other projects?

- Lack of reliable information on target and decoy characteristics
- Distributed computing with unreliable nodes and unreliable channels
- Distributed computing with hard real-time deadlines
- Physical distribution of redundant real-time data
- Hardware failures will not be statistically independent
- Redundancy is unusually expensive
- Information essential for real-time scheduling will not be reliable
- Very limited opportunities for realistic testing
- No opportunity to repair software during use

- Expected to be the largest real-time system ever attempted; frequent changes are anticipated

Why is SDI different from other military software?

1. Because so much would depend on it.
2. Because it will only be used once.
3. Because we cannot know with confidence what it must do.
4. Because we cannot test it under battle conditions.
5. Because it is inherently a distributed system with unreliable nodes and unreliable channels.
6. Because the software is so vital.
7. Because any enemies would focus so much effort on it.

SOFTWARE ESPIONAGE AND NUCLEAR BLACKMAIL

FACT: Software systems, because of their rigid predetermined behaviour, are easily defeated by people who understand the programs.

FACT: Changes in large software systems must be made slowly and carefully with extensive review and testing.

HYPOTHESIS:

1. The U.S. builds an ABM system and depends on it, reducing its arsenal of missiles substantially. Both sides retain a small nuclear arsenal.

2. At some later date a package arrives from the Soviet Embassy. It contains large sections of the ABM program plus commentary making it quite clear that the program has been understood by Soviet scientists. The commentary points out actions that could be taken by an attacker to defeat the defense. The package also contains some demands.

PROBLEM:

1. The defense is probably worthless.

2. There is no time to repair it.

CONCLUSION:

No prudent commander-in-chief would allow the defense of the U.S. to depend on such a system. It would not allow a reduction in arms.

The need for a large software system makes any defensive measure extremely vulnerable.

What about the counter-arguments?

- "SDI is still a research project - new breakthroughs may be found."
- "We can't know that we can't do it until we try."
- "An extensive testing program will overcome these problems."
- "Automatic Programming will solve the problem."
- "Artificial Intelligence will solve the problem."
- "New software engineering techniques will increase reliability."

- Negative thinking! Pessimists have been wrong before.

- SDI opponents are “Liberals”. They don’t want it to work.

Can a new system architecture change things?

- None of the arguments I used is based on a particular architecture

Does decentralisation of algorithms change things?

- Unless there is no cooperation, decentralised algorithms are mathematically equivalent to non-deterministic centralised algorithms.
- Decentralisation introduces new problems that will compensate for the smaller individual programs. Among them deadlock, distributed update problems, resource contention.
- If there is no co-operation, the effectiveness will be greatly reduced because of unused information.

Can Decentralisation Save the Day?

Myth:	10 million lines is too much but 1 million lines are OK.
Fact:	Even 10,000 line programs have to be tested and have subtle bugs.
Myth:	SDI could be a set of totally independent battle stations
Fact:	With battle stations in orbit close to the earth, information must be relayed from one to another for them to be effective.
Fact:	Unless the battle stations communicate, an enemy could get them to "gang up" on decoys and ignore real warheads.

Can Decentralisation Save the Day?

Myth: Communicating "separate" pieces of software cannot have catastrophic failures.

Fact: Sets of Communicating Sequential Processes are mathematically equivalent to a single non-deterministic program.

Fact: In both Telephone Networks and Computer Networks the failure of a single component has been known to have global effects.

Fact: Communicating networks of independent subsystems require nearly perfect specification of interfaces and nearly perfect understanding of those specifications.

Fact: Errors in communicating networks of independent subsystems are the most subtle and hard to find bugs.

Is there a meaningful concept of tolerance for software?

The engineering notion of "tolerance" depends on an assumption of continuity.

Statistical measures of program quality are limited in their application to situations where individual failures are not important.

Is there a fundamental law of computer science that says that SDI cannot work correctly when it is needed?

- No, nobody ever said there was.

Are there fundamental reasons why we are unlikely to have software that works correctly when really needed?

- Yes, we don't know what it must do. We can't verify that it will do what we think it should.

Are there fundamental reasons why we cannot trust the software enough to abandon any other defense?

- Yes, verification is impossible, success is unlikely.

THESE ARE NOT LIMITS ON COMPUTERS.

THEY ARE LIMITS ON HUMAN BEINGS.

Why not do SDI even if it won't be trustworthy?

1. Lost Opportunities for Strengthening our Forces

   Our best talent should be working on things with a chance of success.

2. Program Oriented Research is generally low quality research

   Funds go to those who are the most optimistic, not the most realistic.

3. Our Strategic Position would be weakened.

   USSR Countermeasures are likely to be valuable even if SDI is untrustworthy or abandoned.

---If we build weapons we would not be afraid to use, we are less likely to have to use them.

Senator Warner. Thank you very much for your comments.

We will now proceed to a round of questions. I will ask each Senator to limit his questioning to 5 minutes.

Just an observation, Dr. Parnas, in reference to testing. Much of our present strategic deterrent system has not been tested in the field, as we all know, for very good reasons. As such, there seems to be an element of necessity.

Dr. Buchsbaum, first with your longstanding experience as technical consultant to the Government, do you believe the SDI Program is presently receiving adequate review by experts, both inside and outside Government?

Mr. Buchsbaum. Yes, sir, I believe it does. If anything, it receives too much review. There exists, for example, the SDI Advisory Committee to which I referred. It is a critical body that does not brook nonsense. In a sense, the SDI Program operates in a fishbowl.

My short answer to your question is yes, I believe it does receive adequate review.

Senator Warner. Dr. Cohen.

Mr. Cohen. I would like to second what my colleague says here. I have the same feeling. I serve on the scientific advisory committee of SDIO that has several distinguished scientists there and I was not assigned to be a yes man and I was not briefed by SDI, "Please go tell them what we want them to hear."

We discussed problems. I know they were very receptive and the advisory committee is very critical.

Mr. Parnas. I do not believe it is getting enough close attention. I do not believe that people opposed to the program have enough time or enough resources to really look at detail and be able to make detailed criticisms of the work that is being sponsored.

There is some good work being sponsored, I am quite sure bad work is being sponsored because the bad people are making a lot of promises. I recall one of the conversations I had before agreeing to serve on the panel.

I pointed out to the caller that I had a conflict of interest because I do have a project and I am deeply involved with the U.S. Navy. It is a project that is extremely relevant to these problems and I felt that SDI would be an easy source of money for it. I thought perhaps I should disqualify myself from serving on the panel.

At that time I was given an answer which shocked me, but worried me because I could not think of the counterargument to it. The answer was that SDIO would not want anybody on the panel that did not have that kind of conflict of interest. The reason was if a panelist was not doing relevant work, why should they be on the panel?

One of the things, that worries me is I believe that everybody that is serving as an adviser is somebody that for one reason or another, not having to do with technical feasibility, and sometimes for very honest reasons has a conflict of interest. I also worry about other people not having access to the information to review it.

Senator Warner. Dr. Buchsbaum, to what extent are those responsible for the Battle Management/C^3 aspect of SDI using the architecture of the U.S. telecommunications network as a model?

Mr. **Buchsbaum**. I believe from my understanding of the program right now that is an area which is presently receiving very thorough attention in part through the Scientific Advisory Committee which has set up a BM/C^3 panel chaired by Dr. Spoull, of which I am a member.

We are going to be having our first meeting next week. I do not believe that the program has yet settled on a BM/C^3 architecture. It is early in this game, so to speak. I think the question should be asked in another year or so.

Senator **Warner**. Does any other witness wish to contribute to that question?

Mr. **Cohen**. We highly recommend that the SDI follow the communication paradigm other than the most centralized paradigm. Everyone we talked to is very receptive to that. As a contractor who does the work on an architectural study, I am encouraged to work along those lines.

Senator **Warner**. My time is up, but we will allow the third witness to respond to that question.

Mr. **Parnas**. I agree that that kind of approach is the best approach, the one I always recommend. But I believe there are a number of problems that differentiate SDI from communications network.

One of them is overload control. In communications network you handle overload by dropping some of the jobs. That same technique was taken by Bell Labs in the Safeguard system. If they found they had too many missiles to handle, they simply ignored some of them, otherwise they would end up losing all of them.

What that means is that you have an enemy who has the possibility of overloading the system. The telephone system is not designed to work with a sophisticated enemy trying to make it fail. Techniques used in that situation will not work in this situation.

Senator **Warner**. Thank you.

The subcommittee will now go to vote. We will lead off with Senator Hart when we return.

[Recess.]

Senator **Cohen** [presiding]. We are going to resume the subcommittee hearing pending Senator Warner's return.

I think Senator Hart was scheduled to ask questions next, but he is not here. So, I will proceed for 5 minutes and then yield to Senator Nunn.

Dr. Parnas, you have been described in prior testimony to this subcommittee as being one of the "four gurus" of software computer programming. I would assume that speaks well of your credibility in terms of a witness.

I would like to ask you a question. It seems to me what you have based your testimony upon is that you can never design this system so that it can be adequately tested.

The question I have is: Why could you not test some components of a system and have some measure of reliability?

Mr. **Parnas**. First of all, my augument is not just testing, but also that we cannot know exactly what it is supposed to do. There are two sides to the dilemma because of this.

The second is that we know, because we would not build any system with a collection of components, that we have many, many cases where the components worked and the system still failed because the interfaces were not fully understood.

It is a critical question and my professional life has been devoted to interface connection. The real issue here is that reliability is the wrong word. I have never used the term reliability. It is trustworthiness. There are lots of failures we do not care about.

A system might go down for a minute. The mean time between failures, which is one of the measures of reliability, is not the issue. What we need to know to have confidence in the system is that there are no catastrophic flaws to be exploited by the other side. Testing components will never assure us of that.

Senator COHEN. Dr. Cohen, you are quoted in an article in the July 26, 1985 edition of Science magazine that "Parnas is absolutely right that it cannot be tested; that artificial intelligence probably will not help; that program verification techniques are still in their infancy; and that automatic programming also will not solve this problem. Yet there is a very good chance that this code can be written in less than 5 years. It is, after all, not more complicated that the Apollo Moon shot, by much."

On the one hand you said Parnas is right, it cannot be tested. Yet it seems to me from your testimony you are critical of Dr. Parnas, saying his criticism is not valid because there is no architecture in mind at this point.

Mr. COHEN. Thank you for bringing up this point. I would like to clear the record. I did not write this article the way it was quoted. Sometimes, as some of you people are well aware, quotes are not accurate and sometimes they even quote themselves in what they say.

Senator COHEN. So, he is absolutely wrong now?

Mr. COHEN. Let me go through the thing point by point.

Senator COHEN. Absolutely, it cannot be tested?

Mr. COHEN. Dr. Parnas says we cannot have a full system test.

Senator COHEN. You believe his statement is correct?

Mr. COHEN. We cannot do a full system test short of a war in the same way we cannot do full system work of the SIOP, of our triad, our early warning system.

We did not do any kind of test of the Eagle taking off the Moon. There are many things we cannot test fully and still have very high confidence in our ability to succeed. This part was missed.

Senator COHEN. What about "artificial intelligence probably will not help"? Is that an accurate statement?

Mr. COHEN. Yes. The reason I say that is in the Parnas resignation letter there were several articles and one of them was about artificial intelligence and another was on program verification, and several other techniques that used to be very trendy at one point or another for some people.

Dr. Parnas pointed out none of them is a cure that would solve all problems. I think none of them is a cure to solve all problems and SDI ought to apply the right technique to the right problem.

Senator COHEN. Do you agree with the assumptions we make, for example, with respect to Soviet weapon systems like the SS-18? We make certain assumptions as to how many warheads it may carry because we know how many they have tested, and we have for many years, at least up to this point, abided by the notion that the

Soviets would never deploy a system they had not fully tested? There was some divergence from that belief in recent months and perhaps the past year that I have heard.

Do you basically think there is validity in that—that the Soviets or, indeed, ourselves would not deploy a system that was not fully tested?

Mr. COHEN. My personal belief, whether they do it or not, the important thing for SDI is really to build a system that can be responsive and a system that does not depend on knowing the exact specifics and not trying to outsmart itself and then being easily fooled by the Russians.

The requirement that SDI has has to do more with the basic concept and the basic mode of the Russians, the basic concept like radar cross section or infrared signature that the Russians can reduce, but not eliminate.

Senator COHEN. We have one witness before this panel who said that, in essence, the burden of proof is on the Soviets to show the system is unreliable.

Do you subscribe to that theory?

In other words, the burden of proof is on them to show it is unreliable, not upon us to show that in fact it is reliable?

Mr. COHEN. It goes both ways. General Abrahamson said the system could be considered working if no Russian planner can go to his boss in the Kremlin and say, "We have found a way around it."

We, of course, would have another kind of measure of trustworthiness and we do it by testing evaluation in many ways.

Senator COHEN. General Abrahamson has said the Soviet went to his leader and said we have no countermeasure to this?

Mr. COHEN. No, we should not build a system that the Soviet planner can be sure to go through.

Senator COHEN. What is the other method of our deploying this system?

Mr. COHEN. We trust the system because we tested it in many ways and we will be able to infer from components we can test the performance of the entire system.

We have, obviously, I hope, more data than the Russians would have.

Senator COHEN. Not necessarily. [Laughter.]

Senator WARNER. Senator Nunn.

Senator NUNN. Mr. Chairman, thank you for having these hearings. I think they are very valuable.

I appreciate each of the witnesses being here and spending their time with us.

I think I am hearing a fundamentally different assumption from each of the witnesses. Maybe I am and maybe I am not. I am not sure that the witnesses are very far apart in their scientific testimony, but I think they are far apart in their underlying assumptions.

Dr. Parnas is taking the President seriously in his announced goal. He starts his whole presentation with recitation that the President wants to have a means of rendering these nuclear weapons impotent and obsolete.

So, what his test is, as I understand it—and, Dr. Parnas, you correct me if I am wrong—you want a system where you understand the goal of SDI is to build a system that would indeed render nuclear weapons obsolete and from there you go to the point that it has to be trustworthy and it cannot be subject to catastrophic failure.

Is that correct so far?

Because you are taking the President seriously in that he says he wants to get rid of nuclear weapons, we had better know that SDI is going to work; otherwise, we would never dream of getting rid of nuclear weapons and we would have both a shield and a sword, so to speak.

Mr. PARNAS. The statement I would like better is that he wants to remove the fear of nuclear weapons.

Senator NUNN. You are taking that statement seriously as a goal of SDI. That is the premise from which your logic flows, is it not?

Mr. PARNAS. Yes.

Senator NUNN. You are taking seriously that he wants to abolish nuclear weapons?

Mr. PARNAS. Not so much abolish them, but at least reduce them, that we would rely on the shield.

Senator NUNN. We would not be relying on both deterrent and the shield?

Mr. PARNAS. Yes.

Senator NUNN. I understand the other two witnesses are testifying to something far different from that. You are testifying about a system, like General Abrahamson's statement just said, if you take his statement that what we are talking about is a system that the Soviets would not be confident they could penetrate, that is not a system to do away with nuclear weapons.

That is a system to enhance deterrence. That is a system to enhance the credibility of our retaliatory capability. Those are two fundamentally different things.

Which system are the other two witnesses talking about? Are you talking about the SDI system that would render nuclear weapons obsolete and, therefore, we would be able to greatly reduce our reliance on retaliation or are you talking about a system that is far from perfect, but that enhances deterrence?

I will ask each of the other two witnesses.

Mr. BUCHSBAUM. You put your finger on a key issue. I believe when the President spoke, he made a rhetorical statement. To use that statement as an objective for a program, I am not sure is right.

I am talking about the SDI system similar to your description. I would like to see a world which is much more stable than it is today.

Senator NUNN. You are talking about a system to enhance deterrence retaining our nuclear weapons and our retaliatory capability?

Mr. BUCHSBAUM. And to prevent war, that is right. Now, technically speaking, it is not possible to make a nuclear weapon impotent. The very fact that we are meeting today, that SDI is costing a fortune, is testimony to the potency of nuclear weapons.

From a technical point of view, there is no way to make that thing impotent.

Senator NUNN. I completely agree with you, but I think that is a basic underlying debating point that never gets joined. The President still believes we are going to have a system to make nuclear weapons impotent.

The heart of the testimony by Dr. Parnas is that we will never have a trustworthy system enough to achieve that goal and, therefore, it is a shield and a sword.

It seems to me you are not saying anything very much different. You just have a fundamental basic difference in assumptions. The two of you here, it seems to me, are not agreeing with the President's rhetorical statement as the goal. Dr. Parnas is taking the President literally.

You are welcome to comment on that.

Mr. BUCHSBAUM. I agree with the President's vision of the world where defensive systems play a very important role, perhaps the most important role, in our strategic force structure.

Senator NUNN. But not one that would allow us to do away with nuclear weapons?

Mr. BUCHSBAUM. As a scientist, I do not see how one can make a nuclear weapon impotent.

Senator NUNN. You are agreeing with half of the President's definition, all of it?

Mr. BUCHSBAUM. I am not here to debate the President. I think I have stated my position clearly enough.

Senator NUNN. This is not incidental. This is what the American people are being told. This is how the program is being sold. This is what the TV advertisements are saying. This is the impetus for what we are doing.

I see a whole lot of scientists and administration officials taking half the President's definition and marching off with a program and the other half saying, "Oh, he could not have meant that," and then people who are agreeing with the President's statement, that his words mean something as Dr. Parnas has, are taking it as a goal.

Now, this is a fundamental difference in where we are going. I think it goes to the heart of what the whole problem with SDI is all about right now in terms of controversy. Even though it is a very popular concept to talk about abolishing nuclear weapons, and all of us would like to have that, it is a totally different thing to gear a $40 or $50 billion research program toward that when 99 percent of the people working on that research do not believe that is the goal.

Mr. COHEN. Let me try to answer it by analogy. The President's speech on March 23, 1983, was like instructions the President could give to an architect, saying we need to have a house for a family. This is not exactly the specification.

From that you derive engineering drawings and a lot of very precise specifications, how many rooms you need, what is the structure, how big it is, how wide it is, et cetera, et cetera.

The later speech by the same President in January 1985 stated that what SDI should do now is research in a number of fundamental scientific and engineering questions.

Based on that, according to the President, a future President and a future Congress can make a decision. So, SDI now is a research program that would give us the answer that later will decide if we think it is effective enough that we can have a shield without having to keep nuclear attack resources.

Senator NUNN. You take the President's goal literally. You think you will be able to have a shield that is efficient so that we can do away with our sword or our nuclear weapons?

Mr. COHEN. Yes, this is a goal. In January 1985 his speech sort of reminded us we have to go through a lot of engineering before we can assess whether we can attain it or not, whether we should go ahead with that or not.

Senator NUNN. My time has expired, Mr. Chairman.

Senator WARNER. The Senator from California, Mr. Wilson.

Senator NUNN. If the Senator will yield, Senator Warner pointed out to me that SDI is not aimed in terms of defending against all nuclear weapons, but simply the ballistic missile type. That is very pertinent.

It does not defend against suitcase bombs, against basement bombs, against airplanes, against Piper Cubs flying in with missiles, cruise missiles, and all of that.

Nevertheless, I think that point is well taken, Mr. Chairman.

Senator WILSON. Thank you, Mr. Chairman.

Dr. Parnas, you are, of course, familiar with the system upon which the United States now relies to gain warning that we are under attack by ballistic missiles. That, obviously, is a system that in turn relies heavily on software components.

Wouldn't failure in that current system be as dangerous to us as failure in the software that you are foreseeing for the SDI Program?

Mr. PARNAS. First of all, I believe that the current system is considerably simpler in what it has to do and has more time for manual intervention than SDI has. There is a vast difference in complexity. Technically, it is an easier problem.

Senator WILSON. Wouldn't you also agree it is not only simple, but it offers far less prospect as far as promising in terms of defense?

Mr. PARNAS. No, because whether it is a false alert or not, a false alert we are able to take actions that are reversible and we do not depend on companies as heavily as we would with SDI.

It is also true, by the way, that many of our software controlling ICBM's have not been fully tested because it has not landed on Leningrad. There is a technical difference between the two systems.

In one case, the correctness of our software depends on the properties of the things we build and the laws of physics. We can study those in simulation and do things very close to testing because we know all the properties of our missiles and we can measure the shape of the Earth and magnetic fields.

In the case of the SDI, detecting missiles and shooting them down successfully depends not just on properties of the world and things that we build, but on properties that we cannot know for sure and which we cannot test against. This is a very great difference in the system and our ability to test.

Senator WILSON. I submit there is a great difference in the role assigned and I think there is also an enormous difference in the degree of comfort that anyone would feel with respect to a response that could be made to incoming attack.

Basically, though, I assume you think it is necessary that we have such a system as the early warning system that we have?

Mr. PARNAS. Because it does not hurt anything. I guess my feeling about SDI is that this kind of program is going to make things worse.

Senator WILSON. In other words, you think the current system is irrelevant?

Mr. PARNAS. No, but it is there and everybody has responded to it. You see, I believe that we ought to take what President Reagan says seriously because I think he is eloquent in expressing the yearning of the American people. That is what they want and that is what they are willing to pay for.

Senator WILSON. The point I want to make is this. Would we be better off without the current system because it may in fact one day send us a false signal and touch off a nuclear holocaust?

Mr. PARNAS. It depends on how the other side would have responded if we had not built it. What I am afraid of in this case, by building this thing that turns out to be unreliable, that we do not use it, that the other side will take countermeasures and we will end up in a much worse position.

I am not enough of a historian to know what happened because of what we have now. I know we cannot reverse history. If we just disable that system, we would be in much worse shape. I believe by going ahead with SDI we are hurting ourselves.

Senator WILSON. Let me conclude this by a comment, not my comment, but one by a colleague of yours on the premise that we really should not involve ourselves in so ambitious a system because we cannot adequately test it specifically by mathematical analysis, by modeling, by games testing.

Mr. Chairman, a letter from Prof. John McCarthy of the Department of Computer Science at Stanford University was inserted in the hearing record of October 30. I would like to quote from that letter now. He says:

> First, mathematical techniques exist in proving parts of the program are correct and checking those proofs by computers.
>
> Second, simulated battle conditions can be created that are even more complex and more stressing than a real attack. For example, the test control of war missiles and warheads and decoy defense than the Soviets can ever build and could launch them more quickly and could achieve in an operational environment.

That comment is made in the context, as he states, of some claims by scientists that a computer program needed to realize SDI is impossible to make reliable, a premise that he rejects and rejects in part because of that statement that I have quoted for the record.

I would be interested in having the panel's reaction to that. I think I know from the presentation, but I think that Professor Parnas places heavy reliance on inadequacy of conventional or mathematical or analytical testing or simulation that I think deserves attention from him.

Mr. PARNAS. The first time I heard John McCarthy's statement about that came over an electronic bulletin board. It was accompanied by a further statement that he had not yet read my paper and he never followed the literature of software engineering.

More important, I know what kind of work John McCarthy does. He has made real theoretical breakthroughs, but he works on very small finite State systems. His most famous recent paper deals with monkeys and mechanical problems and 32 State systems, if I remember correctly, and one which he could not prove correct.

It does not have any resemblance of reality. I find the only people who are making strong positive statements about our ability to do this are people who do very theoretical work and people who work on communications systems where the notion of failure is very different.

Senator WILSON. I would be interested in Dr. Cohen's and Dr. Buchsbaum's response to the statement that the test can be even more stressful, more difficult than the real thing because they can pose both greater than real time threats and greater number of responses than are required.

Mr. COHEN. In many military systems, for example pilots' training, simulation is used especially to simulate conditions which are much more stressful than the real world is. In simulation you can have all kinds of situations that you cannot have in any other kind of testing.

You can force to overload lots of units and many interfaces in ways you never would be able to do in testing and things should never occur. For example, in the Apollo system there were five computers. One of them was used to simulate problems. It could cause problems in any place they wanted and any kind of thing that in reality could not happen. The system was stressed way beyond what could be done in any testing in the real world. In this instance I agree with Professor McCarthy.

About the statement that Professor Parnas just said, the only people who say it can be done are people who never worked with a real system. Professor Brooks, in his testimony here before your subcommittee, testified it can be done. I think Professor Brooks has built very, very big systems.

Dr. Vyssotsky from Bell Lab, who built the Safeguard software, also asserted to us his judgment that this can be done.

Mr. BUCHSBAUM. Indeed, I agree with the thrust of the statement. Even today when we deploy large software systems, unlike Dr. Parnas' testimony, their performance is tested under simulated conditions rather than real conditions. Simulation can be used and is used to test large systems.

I slightly disagree with Professor McCarthy's statement. The key problem is to come up with a simulator that comes close to real life conditions, not one that departs from it. That is a real problem because you have to know what the real life conditions are going to be.

Building simulators and an objective system test is relatively easy, but to come up with simulation that approaches reality is a trick that has to be done very carefully.

Senator WILSON. The point you are making is that while it is difficult to challenge the need, it is possible to be even a more stressful situation than in the real world?

Mr. BUCHSBAUM. I agree.

Senator WILSON. Thank you, Mr. Chairman.

Senator WARNER. The Chair intends to remain and if Senator Exon still desires to have a second round, we will have a second round. The Chair would have questions then.

The Chair would like to afford each of the witnesses an opportunity to make such concluding remarks as they may wish. There has been a great deal of benefit in the questioning period and it might reflect on some points that you wish to address.

Senator Nunn.

Senator NUNN. Mr. Chairman, I would like to pose a question to Mr. Buchsbaum.

Mr. Buchsbaum, you work for AT&T?

Mr. BUCHSBAUM. Yes, sir.

Senator NUNN. Your competitor, GTE, has a system called Sprint; is that correct?

Mr. BUCHSBAUM. Yes, sir.

Senator NUNN. Another competitor has a system called Allnet?

Mr. BUCHSBAUM. Yes.

Senator NUNN. If Sprint and Allnet were bent on destroying AT&T's dominant market position, and so forth, how important would an understanding of AT&T software be?

Is that software something that is proprietary?

Mr. BUCHSBAUM. Much of it is proprietary, but most of it is not.

Senator NUNN. Do you have any crucial proprietary data that you feel is worthy of protection?

Mr. BUCHSBAUM. Yes, indeed, we do.

Senator NUNN. Would you turn that over to your competitors?

Mr. BUCHSBAUM. No.

Senator NUNN. What do you think of the proposal to share our SDI technology with the Soviets?

Mr. BUCHSBAUM. In this particular case, they are not competitors, they are adversaries, with whom we share the planet. As I indicated in my statement, Senator, a certain amount of arms control agreement would have to, it seems to me, be put on the books for both sides to be comfortable with the notion of using defensive systems.

Senator NUNN. Can you conceive, though, of turning over your classified information on how the defenses work and your crucial software to the Soviets?

Mr. BUCHSBAUM. I have not thought through, Senator, how I would go about making sure that, trying to make sure that we do not race with each other. That is a very key issue that has to be carefully thought out.

Senator NUNN. You are on the software panel.

Mr. BUCHSBAUM. I am not on Dr. Cohen's software panel, no, sir.

Senator NUNN. Mr. Cohen, what about you? What do you think of the proposal to turn over SDI technology to the Soviets?

Mr. COHEN. I think if we ever get to the point where we are absolutely sure that we can really build a perfect system, then I think I would like to see both of us using the shield and both of us not threatening each other and maybe we will have been able to reach a peaceful state.

If we have a problem with the system, then probably it would make it much harder sharing the system. The less good the system, I would find it less desirable to share it. The better the system is, the easier it would be for me to think about it.

Senator NUNN. Isn't it likely our technology used in SDI by that time would have permeated all our weapon systems, conventional and strategic?

Is the SDI technology going to be something in a box that we put up there for nothing but a defensive system?

Mr. COHEN. The SDI system is aimed at solving the problem of ballistic missiles.

Senator NUNN. There is nothing said that it cannot apply to conventional tactical missiles, is there?

That is what General Abrahamson testified, we have developed our program to cover that.

How are you going to share technology in one system without having the technology spill over in all others that must be permeated by it?

Mr. COHEN. I do not think any of the weapons discussed now in the SDI context are weapons that can work in the lower atmosphere. This would apply against low-flying cruise missiles, for example.

Senator NUNN. That is not the testimony we received. The testimony we received is that the SDI program is going to lap over in those areas. My recollection is that comes from the head of the program, but the record will stand on that.

Let me ask Dr. Parnas about his view of technology sharing in this area.

Mr. PARNAS. One of the things I wish we could do, as I said in my original testimony, if I know what somebody else's computer program is going to do, it is only a matter of time before I can find a flaw in it.

Now, Dr. Cohen is one who believes we can get a perfect system. I certainly do not.

Senator NUNN. If you were to share that, in other words, you would have to have perfect confidence in the Soviets not using your information to counter your system and would become dominant again?

Mr. PARNAS. There is in the DARPA strategic computer initiative paper showing their new program a story about how two warring parties who had the same radar system. One of them read the program they both shared. They found a flaw and were able to attack without risk. I cannot imagine sharing the SDI technology.

Senator NUNN. Thank you, Mr. Chairman.

I thank all the witnesses for being here.

Senator WARNER. Gentlemen, I would like to pose a question. It is a question that this committee has to search for with each of its witnesses to see if we can formulate some position. That relates to the important relationship between arms control and the SDI program.

We see frequent references to one of the options that arms control may pursue at some point in time, and that is the goal of enabling both superpowers to have a strategic posture consisting of both offensive weapons and defensive weapons.

Now, for the moment the SDI Program is designed to produce a system that will interdict only strategic ballistic missiles leaving, as Senator Nunn and I pointed out, the air-breathing leg and other forms of nuclear systems in the present posture.

The specific question is: Does technology enable the SDI Program to devise a defensive system which can be described and verified as only partially capable?

I mean by that that it would not serve as a total shield intentionally, but it would interdict, say, 50 percent of the incoming ICBM's.

Now, my own view is that all arms control arrangements have to be predicated on a balance, overall balance, between the Soviet Union and the United States. The objective, as stated by the President, is to bring down the level to 50 percent again without specifically describing what systems, and so forth, warheads, launchers, or a mix.

But assuming that that goal can be defined, then is there an option for either nation to pursue a strategic deterrent within that formula that is partially offensive and partially defensive, with the technology of SDI directed toward ballistic missiles?

Does anyone wish to volunteer to tackle that?

Mr. BUCHSBAUM. Your specific question is: Can a system be deployed by both sides?

Senator WARNER. Beg your pardon?

Mr. BUCHSBAUM. If I read your question correctly, can a system be deployed by the United States and the Soviet Union, a similar system?

Let us talk about the United States which has certain other capabilities and those capabilities are verifiable by some means. I believe the answer is yes. I believe if and when the United States chooses to deploy a defensive system, its capabilities will be well known and be well understood by both sides or reasonably well known and understood by both sides.

Senator WARNER. Do you see the term used in respect to bombers, limited deployment of a SDI system?

Yet as we receive testimony, the goal as outlined by the President, one which I personally do not subscribe to, is that SDI will be an overall shield that would interdict all of the incoming ballistic missiles.

It is possible then, and I think your answer is yes, to devise a limited SDI, there could be a limited deployment of a SDI system which in a verifiable manner could interdict, say, half of the potential incoming ballistic missiles?

Would that limited deployment be a mix of, shall we say, units in space and software or would it be controlled by software?

In other words, the system would work against 50 percent of the incoming weapons and suddenly shut off. That would pose a very substantial verification problem, in my judgment.

Mr. BUCHSBAUM. It certainly would have to be, whatever capability, it would have to be a mixture of both hardware and software. I cannot imagine any system today without any software.

Senator WARNER. I meant software someone pointed out could be programmed to operate the system and then shut it down. This is all very theoretical, but we have to pin down whether or not there is any credibility to these terms of limited deployment of SDI, a mixed defense-offense.

Mr. BUCHSBAUM. The notion that a system will be shut down is not an appealing one to me. I do not understand how that would work. The notion that is more appealing is you deploy a system whose maximum capability, if you will, is well known. It is only capable of shooting down *x* number of missiles. After that it is exhausted.

Senator WARNER. So, it would be inherently capable of shooting down *x* number and then because of loading of the various weapons, that is its limit?

Mr. BUCHSBAUM. Exactly.

Senator WARNER. Does any other witness care to deal with this?

Mr. PARNAS. I guess I would like to say one of the troubles I see is that we cannot measure the system using percentages like 50 percent. The SDI office uses the 90-percent or 95-percent or 85-percent figure which they seem to have gotten out of thin air.

When you use figures like that, you are assuming the thing is a random process. It is not a random process. If we ever have a battle with these systems, it will be a battle of skills. They will only begin an attack if they have some assurance that they have a countermeasure.

We have had cases of defensive systems in the case of Israeli against Syrians where they found a countermeasure that allowed them to get 100 percent of what they wanted. So, we would have a system up there that the most the system could do is 50 percent, but we never could be sure it would do more than zero.

We never even have a high probability of it because they would not attack until they had some countermeasure like that. That is why I am frightened.

Senator WARNER. Dr. Cohen.

Mr. COHEN. You talk about the notion of limited deployment. Obviously, the goal that the President stated which is so appealing is a perfect shield, the goal like having a big house, the question is how much can we afford?

The hope is that at this stage of research, in the first stage of SDI, we can make some reasonable assumptions and make reasonable informative decisions about what we can afford. I would like to see it as being as close to perfect as possible. Maybe we will never be able to afford it, maybe we will. I do not know.

The promise is so large and so appealing that we must do the research to find out, rather than making a harsh judgment that we cannot. I agree there is no point in talking about percentages. We should talk about numbers. We should talk about number of missiles, not percentage. That is in the context of knowing how many missiles exist, then there is some correspondence between the two of them and both make sense.

Senator WARNER. Dr. Parnas, this question. In the arms control arena, indeed, in the summit just concluded, the Soviets have put an awful lot of emphasis on the need for this Nation to stop the SDI Program.

Could there be a point in time, and I am not suggesting that the President has an option at this moment, but there could be a point in time when indeed this administration determined that they might opt out of SDI for some arms control arrangement?

My question specifically is: Aren't the Soviets subject to so much political capital and emphasis on the need to stop SDI, there is a substantial body of opinion that supports your thesis, namely, that it cannot be made to work?

Mr. **Parnas**. Let me begin to answer that by pointing out it is not a computer science question. It is something I have given a lot of thought to. I reassured myself in making the move I did, and I did a lot of soul searching. It seems to me that there are three possible explanations for the Russians' behavior.

One is that they really do not know that we cannot make it reliable. I do not believe that. I know a few East bloc computer scientists and they know as much as we do.

The second is we take at face value the argument they make, economic burden, and it will get us nowhere. We will be in the same situation 25 years from now.

The third is what occurred to me while reading a story to my little girl, that maybe they have a Russian version of "The Tale of Brer Rabbit." Maybe they know this is going to weaken us because we are going to put our best talent on something that will not really help.

When we wake up to the fact that we have wasted our efforts on such a thing, they will be way ahead. I do not think we can get any information from what the Russians tell us. They are too clever for that.

Senator **Warner**. Do other witnesses care to answer that question?

Mr. **Buchsbaum**. I asked that question myself. I conclude that the Russians want us to stop because they are concerned that we might succeed. They invested some effort in it with some success and they are concerned that we will succeed ahead of them.

Mr. **Cohen**. I came to the same conclusion. I do not think the Russians are trying to fool us by screaming against it.

The one crucial technology that exists that we have and they do not is information processing. They can keep up with any other technology, but we are so much ahead of them in information processing that they are really scared that we will be able to do it and they cannot.

Senator **Warner**. Gentlemen, I have to vote, but I thought I would give each of you a minute or so, recognizing I have to make the floor, to make any summarized statement which you would like to make.

Mr. **Parnas**. I would like to begin by asking that some written statements I have brought with me be made part of the record.

Senator **Warner**. The record will remain open for 10 days during which period of time members of the subcommittee might wish to submit questions and you will have an opportunity to amplify on your statements.

Mr. **Parnas**. The other part of the closing statement that I make is partly in response to what Senator Nunn has said, that what bothered me and forced me to take the position that I did is the feeling that people are believing President Reagan's talk and that it is dishonest to go on with this research unless President Reagan understands and tells the public, and they believe him, that this will not give us this kind of shield.

I personally see enough exciting and interesting technical problems in this that if everybody understands this will not provide an end to the arms race or really change the balance in any way, I would be willing to participate again.

Senator WARNER. Mr. Buchsbaum, do you have a closing statement?

I am going to follow an unusual procedure and ask you to make it for the record and not exceed 3 minutes. I have to depart. Counsel will close the hearing.

Mr. BUCHSBAUM. Could we submit it in writing?

Senator WARNER. Yes.

[The closing statements follow:]

CLOSING STATEMENT BY DR. SOLOMON BUCHSBAUM

Thank you, Mr. Chairman, for the opportunity to make a closing statement. I will stay within my allotted three minutes.

I would like to comment first on Professor Parnas' comments and to make just two points.

Professor Parnas should be more careful with his facts: Bell Laboratories does not, as he claims, test its software systems during the soak cycle against real traffic. It tests them against simulated loads. And his statement that the Safeguard system was abandoned because it was "unreliable" is simply false. Indeed, Safeguard was discontinued as an ABM system, but not for the reasons Dr. Parnas cites. Its software, in particular, was very reliable and very effective as extensive tests have shown. I believe, the US Army was very pleased with its performance.

In fact the system is still being used today. The installation in North Dakota is still operated by the military to detect and determine the characteristics of a missile attack. It is also used to track and record some 35,000 objects in space on a daily basis. This data is automatically transmitted to NORAD. The system has never experienced a crash in its ten years of operation. No false alerts were transmitted to NORAD. When the system was overloaded by simulated targets it continued to function to its designed capacity.

Nevertheless, the problems that Dr. Parnas lists that a designer has to consider when he designs a system are real. But they are not new or unknown to competent designers. Indeed, it is possible to design and build systems that are brought down by a single, catastrophic failure. Dr. Parnas cites the DARPA network as an example. I do not dispute that.

The point of my testimony is simply that it is also possible to design, build and operate network systems, such as the SDI BM/C^3 system, which need not suffer from the problems Dr. Parnas enumerates. They do not suffer from those problems simply because they have all been taken into account during the design of the system.

CLOSING STATEMENT OF DR. DANNY COHEN

Mr. Chairman, I appreciate very much the opportunity that I was given to share my views on SDI with you.

Several important points were raised during this session and I'd like to address to some of them.

The basic argument against the feasibility of a trustworthy strategic defense system is its unique characteristics as a system that cannot be fully tested under realistic battle conditions and whose performance cannot be inferred from tests at a smaller scale. The critics base this argument on the dependence of the performance not only on the laws of physics, and on our products but also on the properties of enemy systems whose properties cannot be predicted with high confidence.

The flaw in this argument was pointed out by Senators Warner and Wilson. The same inability to fully test under realistic battle conditions and the same dependence on the properties of enemy systems do exist in nearly all other military systems, such as the ASW and early warning systems and the operation of our strategic forces. The SDI is not unique in this sense, and its proper design and extensive testing will provide the basis for its trustworthiness and reliability.

We were asked whether we are better off with the current offense-based system or will we be better off with a defense-based system. A defense-based balance would be more stable than the current dangerous MAD-based doctrine, under which our only response to any indication that we are under attack (right or wrong) is a nuclear retaliation which may lead to a holocaust, whereas in the same situation with the SDI system mistakes are less irreversible and less costly.

Senator Nunn brought up an important issue of technology sharing with the Russians. I believe that we should discuss a mutually verified sharing of our and their technologies, not just ours. Such a discussion might provide a better perspective on this important issue.

Senator Nunn, when inquiring to how seriously each of us takes the president's objective, brought up the issue of the completeness of the coverage provided by SDI. It is my opinion that only at the completion of the current stage, in which we explore the scientific and the technical parameters of strategic defense technology, we will be able to make intelligent decisions about what kind of coverage we seek, and how much we would be willing to pay for what level of security.

What is needed now is the ability to carry on the technical work in order to be able, within a few years, to address this important and complex issue in an informed manner so that we can then make intelligent decisions about deployment.

Thank you, again, Mr. Chairman and the members of the committee.

[Additional material provided for the hearing record by Dr. David Parnas.]

Software Aspects of Strategic Defense Systems

David Lorge Parnas

Views

A former member of the SDIO Panel on Computing in Support of Battle Management explains why he believes the "star wars" effort will not achieve its stated goals

On 28 June 1985, David Lorge Parnas, a respected computer scientist who has consulted extensively on United States defense projects, resigned from the Panel on Computing in Support of Battle Management, convened by the Strategic Defense Initiative Organization (SDIO). With his letter of resignation, he submitted eight short essays explaining why he believed the software required by the Strategic Defense Initiative would not be trustworthy. Excerpts from Dr. Parnas's letter and the accompanying papers have appeared widely in the press. The Editors of American Scientist *believe that it would be useful to the scientific community to reprint these essays in their entirety to stimulate scientific discussion of the feasibility of the project.*

This report comprises eight short papers that were completed while I was a member of the Panel on Computing in Support of Battle Management, convened by the Strategic Defense Initiative Organization (SDIO). SDIO is part of the Office of the US Secretary of Defense. The panel was asked to identify the computer science problems that would have to be solved before an effective antiballistic missile (ABM) system could be deployed. It is clear to everyone that computers must play a critical role in the systems that SDIO is considering. The essays that constitute this report were written to organize my thoughts on these topics and were submitted to SDIO with my resignation from the panel.

The requirements of a strategic defense system

In March 1983, President Reagan said, "I call upon the scientific community, who gave us nuclear weapons, to turn their great talents to the cause of mankind and world peace: to give us the means of rendering these nuclear weapons impotent and obsolete."

To satisfy this request the software must perform the following functions:

- — Rapid and reliable warning of attack
- — Determination of the source of the attack
- — Determination of the likely targets of the attack
- — Determination of the missile trajectories
- — Coordinated interception of the missiles or warheads during boost, midcourse, and terminal phases, including assignment of responsibility for targets to individual sensors or weapons
- — Discrimination between decoys and warheads
- — Detailed control of individual weapons
- — Evaluation of the effectiveness of each attempt to destroy a target

My conclusions are not based on political or policy judgments. Unlike many other academic critics of the SDI effort, I have not, in the past, objected to defense efforts or defense-sponsored research. I have been deeply involved in such research and have consulted extensively on defense projects. My conclusions are based on more than 20 years of research on software engineering, including more than 8 years of work on real-time software used in military aircraft. They are based on familiarity with both operational military software and computer science research. My conclusions are based on characteristics peculiar to this particular effort, not objections to weapons development in general.

I am publishing the papers that accompanied my letter of resignation so that interested people can understand why many computer scientists believe that systems of the sort being considered by the SDIO cannot be built. These essays address the software engineering aspects of SDIO and the organization of engineering research. They avoid political issues; those have been widely discussed elsewhere, and I have nothing to add.

In these essays I have attempted to avoid technical jargon, and readers need not be computer programmers to understand them. They may be read in any order.

The individual essays explain:

1. The fundamental technological differences between software engineering and other areas of engineering and why software is unreliable;
2. The properties of the proposed SDI software that make it unattainable;
3. Why the techniques commonly used to build military software are inadequate for this job;
4. The nature of research in software engineering, and why the improvements that it can effect will not be sufficient to allow construction of a truly reliable strategic defense system;
5. Why I do not expect research in artificial intelligence to help in building reliable military software;
6. Why I do not expect research in automatic programming to bring about the substantial improvements that are needed;
7. Why program verification (mathematical proofs of correctness) cannot give us a reliable strategic defense battle-management system;
8. Why military funding of research in software and other aspects of computing science is inefficient and ineffective. This essay responds to the proposal that SDIO should be funded even if the ABM system cannot be produced, because the program will produce good research.

Why software is unreliable

I. Introduction

People familiar with both software engineering and older engineering disciplines observe that the state of the art in software is significantly behind that in other areas of engineering. When most engineering products have been completed, tested, and sold, it is reasonable to expect that the product design is correct and that it will work reliably. With software products, it is usual to find that the software has major "bugs" and does not work reliably for some users. These problems may persist for several versions and sometimes worsen as the software is "improved." While most products come with an express or implied warranty, software products often carry a specific disclaimer of warranty. The lay public, familiar with only a few incidents of software failure, may regard them as exceptions caused by inept programmers. Those of us who are software professionals know better; the most competent programmers in the world cannot avoid such problems. This section discusses one reason for this situation.

II. System types

Engineering products can be classified as discrete state systems, analog systems, or hybrid systems.

Discrete state or digital systems are made from components with a finite number of stable states. They are designed in such a way that the behavior of the system when not in a stable state is not significant.

Continuous or analog systems are made from components that, within a broad operating range, have an infinite number of stable states and whose behavior can be adequately described by continuous functions.

Hybrid systems are mixtures of the two types of components. For example, we may have an electrical circuit containing, in addition to analog components, a few components whose descriptive equations have discontinuities (e.g., diodes). Each of these components has a small number of discrete operating states. Within these states its behavior can be described by continuous functions.

III. Mathematical tools

Analog systems form the core of the traditional areas of engineering. The mathematics of continuous functions is well understood. When we say that a system is described by continuous functions we are saying that it can contain no hidden surprises. Small changes in inputs will always cause correspondingly small changes in outputs. An engineer who ensures, through careful design, that the system components are always operating within their normal operating range can use a mathematical analysis to ensure that there are no surprises. When combined with testing to ensure that the components are within their operating range, this leads to reliable systems.

Before the advent of digital computers, when discrete state systems were built, the number of states in such systems was relatively small. With a small number of states, exhaustive testing was possible. Such testing compensated for the lack of mathematical tools corresponding to those used in analog systems design. The engineers of such systems still had systematic methods that allowed them to obtain a complete understanding of their system's behavior.

The design of many hybrid systems can be verified by a combination of the two methods. We can then identify a finite number of operating states for the components with discrete behavior. Within those states, the system's behavior can be described by continuous functions. Usually the number of states that must be distinguished is small. For each of those states, the tools of continuous mathematics can be applied to analyze the behavior of the system.

With the advent of digital computers, we found the first discrete state systems with very large numbers of states. However, to manufacture such systems it was necessary to construct them using many copies of very small digital subsystems. Each of those small subsystems could be analyzed and tested exhaustively. Because of the repetitive structure, exhaustive testing was not necessary to obtain correct and reliable hardware. Although design errors are found in computer hardware, they are considered exceptional. They usually occur in those parts of the computer that are not repetitive structures.

Software systems are discrete state systems that do not have the repetitive structure found in computer circuitry. There is seldom a good reason to construct software as highly repetitive structures. The number of states in software systems is orders of magnitude larger than the number of states in the nonrepetitive parts of computers. The mathematical functions that describe the behavior of these systems are not continuous functions, and traditional engineering mathematics does not help in their verification. This difference clearly contributes to the relative unreliability of software systems and the apparent lack of competence of software engineers. It is a fundamental difference that will not disappear with improved technology.

IV. How can we understand software?

To ameliorate the problems caused by this fundamental difference in technology two techniques are available: (1) the building of software as highly organized collections of small programs and (2) the use of mathematical logic to replace continuous mathematics.

Dividing software into modules and building each module of so-called "structured" programs clearly helps. When properly done, each component deals with a small number of cases and can be completely analyzed. However, real software systems have many such components, and there is no repetitive structure to simplify the analysis. Even in highly structured systems, surprises and unreliability occur because the human mind is not able to fully comprehend the many conditions that

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can arise because of the interaction of these components. Moreover, finding the right structure has proved to be very difficult. Well-structured real software systems are still rare.

Logic is a branch of mathematics that can deal with functions that are not continuous. Many researchers believe that it can play the role in software engineering that continuous mathematics plays in mechanical and electrical engineering. Unfortunately, this has not yet been verified in practice. The large number of states and lack of regularity in the software result in extremely complex mathematical expressions. Disciplined use of these expressions is beyond the computational capacity of both the human programmer and current computer systems. There is progress in this area, but it is very slow, and we are far from being able to handle even small software systems. With current techniques the mathematical expressions describing a program are often notably harder to understand than the program itself.

V. The education of programmers

Worsening the differences between software and other areas of technology is a personnel problem. Most designers in traditional engineering disciplines have been educated to understand the mathematical tools that are available to them. Most programmers cannot even begin to use the meager tools that are available to software engineeers.

Why the SDI software system will be untrustworthy

I. Introduction

In March 1983, the President called for an intensive and comprehensive effort to define a long-term research program with the ultimate goal of eliminating the threat posed by nuclear ballistic missiles. He asked us, as members of the scientific community, to provide the means of rendering these nuclear weapons impotent and obsolete. To accomplish this goal we would need a software system so well-developed that we could have extremely high confidence that the system would work correctly when called upon. In this section I will present some of the characteristics of the required battle-management software and then discuss their implications on the feasibility of achieving that confidence.

II. Characteristics of the proposed battle-management software system

1. The system will be required to identify, track, and direct weapons toward targets whose ballistic characteristics cannot be known with certainty before the moment of battle. It must distinguish these targets from decoys whose characteristics are also unknown.

2. The computing will be done by a network of computers connected to sensors, weapons, and each other, by channels whose behavior, at the time the system is invoked, cannot be predicted because of possible countermeasures by an attacker. The actual subset of system components that will be available at the time that the system is put into service, and throughout the period of service, cannot be predicted for the same reason.

3. It will be impossible to test the system under realistic conditions prior to its actual use.

4. The service period of the system will be so short that there will be little possibility of human intervention and no possibility of debugging and modification of the program during that period of service.

5. Like many other military programs, there are absolute real-time deadlines for the computation. The computation will consist primarily of periodic processes, but the number of those processes that will be required, and the computational requirements of each process, cannot be predicted in advance because they depend on target characteristics. The resources available for computation cannot be predicted in advance. We cannot even predict the "worst case" with any confidence.

6. The weapon system will include a large variety of sensors and weapons, most of which will themselves require a large and complex software system. The suite of weapons and sensors is likely to grow during development and after deployment. The characteristics of weapons and sensors are not yet known and are likely to remain fluid for many years after deployment. The result is that the overall battle-management software system will have to integrate a software system significantly larger than has ever been attempted before. The components of that system will be subject to independent modification.

III. Implications of these problem characteristics

Each of these characteristics has clear implications on the feasibility of building battle-management software that will meet the President's requirements.

1. Fire-control software cannot be written without making assumptions about the characteristics of enemy weapons and targets. This information is used in determining the recognition algorithms, the sampling periods, and the noise-filtering techniques. If the system is developed without the knowledge of these characteristics, or with the knowledge that the enemy can change some of them on the day of battle, there are likely to be subtle but fatal errors in the software.

2. Although there has been some real progress in the area of "fail-soft" computer software, I have seen no success except in situations where (a) the likely failures can be predicted on the basis of past history, (b) the component failures are unlikely and are statistically independent, (c) the system has excess capacity, (d) the real-time deadlines, if any, are soft, i.e., they can be missed without long-term effects. None of these is true for the required battle-management software.

3. No large-scale software system has ever been installed without extensive testing under realistic conditions. For example, in operational software for military aircraft, even minor modifications require extensive ground testing followed by flight testing in which battle conditions can be closely approximated. Even with these tests, bugs can and do show up in battle conditions. The inability to test a strategic defense system under field conditions before we actually need it will mean that no knowledgeable person would have much faith in the system.

4. It is not unusual for software modifications to be made in the field. Programmers are transported by helicopter to Navy ships; debugging notes can be found

on the walls of trucks carrying computers that were used in Vietnam. It is only through such modifications that software becomes reliable. Such opportunities will not be available in the 30–90 minute war to be fought by a strategic defense battle-management system.

5. Programs of this type must meet hard real-time deadlines reliably. In theory, this can be done either by scheduling at runtime or by pre-runtime scheduling. In practice, efficiency and predictability require some pre-runtime scheduling. Schedules for the worst-case load are often built into the program. Unless one can work out worst-case real-time schedules in advance, one can have no confidence that the system will meet its deadlines when its service is required.

6. All of our experience indicates that the difficulties in building software increase with the size of the system, with the number of independently modifiable subsystems, and with the number of interfaces that must be defined. Problems worsen when interfaces may change. The consequent modifications increase the complexity of the software and the difficulty of making a change correctly.

IV. Conclusion

All of the cost estimates indicate that this will be the most massive software project ever attempted. The system has numerous technical characteristics that will make it more difficult than previous systems, independent of size. Because of the extreme demands on the system and our inability to test it, we will never be able to believe, with any confidence, that we have succeeded. Nuclear weapons will remain a potent threat.

Why conventional software development does not produce reliable programs

I. What is the conventional method?

The easiest way to describe the programming method used in most projects today was given to me by a teacher who was explaining how he teaches programming. "Think like a computer," he said. He instructed his students to begin by thinking about what the computer had to do first and to write that down. They would then think about what the computer had to do next and continue in that way until they had described the last thing the computer would do. This, in fact, is the way I was taught to program. Most of today's textbooks demonstrate the same method, although it has been improved by allowing us to describe the computer's "thoughts" in larger steps and later to refine those large steps to a sequence of smaller steps.

II. Why this method leads to confusion

This intuitively appealing method works well—on problems too small to matter. We think that it works because it worked for the first program that we wrote. One can follow the method with programs that have neither branches nor loops. As soon as our thinking reaches a point where the action of the computer must depend on conditions that are not known until the program is running, we must deviate from the method by labeling one or more of the actions and remembering how we would get there. As soon as we introduce loops into the program, there are many ways of getting to some of the points and we must remember all of those ways. As we progress through the algorithm, we recognize the need for information about earlier events and add variables to our data structure. We now have to start remembering what data mean and under what circumstances data are meaningful.

As we continue in our attempt to "think like a computer," the amount we have to remember grows and grows. The simple rules defining how we got to certain points in a program become more complex as we branch there from other points. The simple rules defining what the data mean become more complex as we find other uses for existing variables and add new variables. Eventually, we make an error. Sometimes we note that error; sometimes it is not found until we test. Sometimes the error is not very important; it happens only on rare or unforeseen occasions. In that case, we find it when the program is in use. Often, because one needs to remember so much about the meaning of each label and each variable, new problems are created when old problems are corrected.

III. What is the effect of concurrency on this method?

In many of our computer systems there are several sources of information and several outputs that must be controlled. This leads to a computer that might be thought of as doing many things at once. If the sequence of external events cannot be predicted in advance, the sequence of actions taken by the computer is also not predictable. The computer may be doing only one thing at a time, but as one attempts to "think like a computer," one finds many more points where the action must be conditional on what happened in the past. Any attempt to design these programs by thinking things through in the order that the computer will execute them leads to confusion and results in systems that nobody can understand completely.

IV. What is the effect of multiprocessing?

When there is more than one computer in a system, the software not only appears to be doing more than one thing at a time, it really is doing many things at once. There is no sequential program that one can study. Any attempt to "think like the computer system" is obviously hopeless. There are so many possibilities to consider that only extensive testing can begin to sort things out. Even after such testing, we have incidents such as one that happened on a space shuttle flight several years ago. The wrong combination of sequences occurred and prevented the flight from starting.

V. Do professional programmers really use this approach?

Yes. I have had occasion to study lots of practical software and to discuss programs with lots of professional programmers. In recent years many programmers have tried to improve their working methods using a variety of software design approaches. However, when they get down to writing executable programs, they revert to the conventional way of thinking. I have yet to find a substantial program in practical use whose structure was not based on the expected execution sequence. I would be happy to be shown some.

Other methods are discussed in advanced courses, a few good textbooks, and scientific meetings, but most programmers continue to use the basic approach of thinking things out in the order that the computer will execute them. This is most noticeable in the maintenance (deficiency correction) phase of programming.

VI. How do we get away with this inadequate approach?

It should be clear that writing and understanding very large real-time programs by "thinking like a computer" will be beyond our intellectual capabilities. How can it be that we have so much software that is reliable enough for us to use it? The answer is simple; programming is a trial and error craft. People write programs without any expectation that they will be right the first time. They spend at least as much time testing and correcting errors as they spent writing the initial program. Large concerns have separate groups of testers to do quality assurance. Programmers cannot be trusted to test their own programs adequately. Software is released for use, not when it is known to be correct, but when the rate of discovering new errors slows down to one that management considers acceptable. Users learn to expect errors and are often told how to avoid the bugs until the program is improved.

VII. Conclusion

The military software that we depend on every day is not likely to be correct. The methods that are in use in the industry today are not adequate for building large real-time software systems that must be reliable when first used. A drastic change in methods is needed.

The limits of software engineering methods

I. What is software engineering research?

We have known for 25 years that our programming methods are inadequate for large projects. Research in software engineering, programming methodology, software design, etc., looks for better tools and methods. The common thrust of results in these fields is to reduce the amount that a programmer must remember when checking and changing a program.

Two main lines of research are (1) structured programming and the use of formal program semantics and (2) the use of formally specified abstract interfaces to hide information about one module (work assignment) from the programmers who are working on other parts. A third idea, less well understood but no less important, is the use of cooperating sequential processes to help deal with the complexities arising from concurrency and multiprogramming. By the late 1970s the basic ideas in software engineering were considered "motherhood" in the academic community. Nonetheless, examinations of real programs revealed that actual programming practice, especially for military systems, had not been changed much by the publication of the academic proposals.

The gap between theory and practice was large and growing. Those espousing structured approaches to software were certain that it would be easy to apply their ideas to the problems that they faced in their daily work. They doubted that programs organized according to the principles espoused by academics could ever meet the performance constraints on "real" systems. Even those who claimed to believe in these principles were not able to apply them consistently.

In 1977 the management of the Naval Research Laboratory in Washington, DC, and the Naval Weapons Center in China Lake, California, decided that something should be done to close the gap. They asked one of the academics who had faith in the new approach (myself) to demonstrate the applicability of those methods by building, for the sake of comparison, a second version of a Navy real-time program. The project, now known as the Software Cost Reduction project (SCR), was expected to take two to four years. It is still going on.

The project has made two things clear: (1) much of what the academics proposed can be done; (2) good software engineering is far from easy. The methods reduce, but do not eliminate, errors. They reduce, but do not eliminate, the need for testing.

II. What should we do and what can we do?

The SCR work has been based on the following precepts:

1. The software requirements should be nailed down with a complete, black-box requirements document before software design is begun.
2. The system should be divided into modules using information-hiding (abstraction) before writing the program begins.
3. Each module should have a precise, black-box, formal specification before writing the program begins.
4. Formal methods should be used to give precise documentation.
5. Real-time systems should be built as a set of cooperating sequential processes, each with a specified period and deadline.
6. Programs should be written using the ideas of structured programming as taught by Harlan Mills.

We have demonstrated that the first four of these precepts can be applied to military software by doing it. The documents that we have written have served as models for others. We have evidence that the models provide a most effective means of technology transfer.

We have not yet proved that these methods lead to reliable code that meets the space and time constraints. We have found that every one of these precepts is easier to pronounce than to carry out. Those who think that software designs will become easy, and that errors will disappear, have not attacked substantial problems.

III. What makes software engineering hard?

We can write software requirements documents that are complete and precise. We understand the mathematical model behind such documents and can follow a systematic procedure to document all necessary requirements decisions. Unfortunately, it is hard to make the decisions that must be made to write such a document. We often do not know how to make those decisions until we can play with the system. Only when we have built a similar system before is it easy to determine the requirements in advance. It is worth doing, but it is not easy.

We know how to decompose complex systems into modules when we know the set of design decisions that must be made in the implementation. Each of these must be assigned to a single module. We can do that when we are building a system that resembles a system we built before. When we are solving a totally new problem, we will overlook difficult design decisions. The result will be a structure that does not fully separate concerns and minimize complexity.

We know how to specify abstract interfaces for modules. We have a set of standard notations for use in that task. Unfortunately, it is very hard to find the right interface. The interface should be an abstraction of the set of all alternative designs. We can find that abstraction only when we understand the alternative designs. For example, it has proved unexpectedly hard to design an abstract interface that hides the mathematical model of the earth's shape. We have no previous experience with such models and no one has designed such an abstraction before.

The common thread in all these observations is that, even with sound software design principles, we need broad experience with similar systems to design good, reliable software.

IV. Will new programming languages make much difference?

Because of the very large improvements in productivity that were noted when compiler languages were introduced, many continue to look for another improvement by introducing better languages. Better notation always helps, but we cannot expect new languages to provide the same magnitude of improvement that we got from the first introduction of such languages. Our experience in SCR has not shown the lack of a language to be a major problem.

Programming languages are now sufficiently flexible that we can use almost any of them for almost any task. We should seek simplifications in programming languages, but we cannot expect that this will make a big difference.

V. What about programming environments?

The success of UNIX™ as a programming development tool has made it clear that the environment in which we work does make a difference. The flexibility of UNIX™ has allowed us to eliminate many of the time-consuming housekeeping tasks involved in producing large programs. Consequently, there is extensive research in programming environments. Here, too, I expect small improvements can be made by basing tools on improved notations but no big breakthroughs. Problems with our programming environment have not been a major impediment in our SCR work.

VI. Why software engineering research will not make the SDI goals attainable

Although I believe that further research on software engineering methods can lead to substantial improvements in our ability to build large real-time software systems, this work will not overcome the difficulties inherent in the plans for battle-management computing for SDI. Software engineering methods do not eliminate errors. They do not eliminate the basic differences between software technology and other areas of engineering. They do not eliminate the need for extensive testing under field conditions or the need for opportunities to revise the system while it is in use. Most important, we have learned that the successful application of these methods depends on experience accumulated while building and maintaining similar systems. There is no body of experience for SDI battle management.

VII. Conclusion

I am not a modest man. I believe that I have as sound and broad an understanding of the problems of software engineering as anyone that I know. If you gave me the job of building the system, and all the resources that I wanted, I could not do it. I don't expect the next 20 years of research to change that fact.

Artificial intelligence and the Strategic Defense Initiative

I. Introduction

One of the technologies being considered for use in the SDI battle-management software is artificial intelligence (AI). Researchers in AI have often made big claims, and it is natural to believe that one should use this technology for a problem as difficult as SDI battle management. In this section, I argue that one cannot expect much help from AI in building reliable battle-management software.

II. What is artificial intelligence?

Two quite different definitions of AI are in common use today.

AI-1: The use of computers to solve problems that previously could be solved only by applying human intelligence.

AI-2: The use of a specific set of programming techniques known as heuristic or rule-based programming. In this approach human experts are studied to determine what heuristics or rules of thumb they use in solving problems. Usually they are asked for their rules. These rules are then encoded as input to a program that attempts to behave in accordance with them. In other words, the program is designed to solve a problem the way that humans seem to solve it.

It should be noted that the first definition defines AI as a set of problems, the second defines AI as a set of techniques. The first definition has a sliding meaning. In the Middle Ages, it was thought that arithmetic required intelligence. Now we recognize it as a mechanical act. Something can fit the definition of AI-1 today, but, once we see how the program works and understand the problem, we will not think of it as AI anymore.

It is quite possible for a program to meet one definition and not the other. If we build a speech-recognition program that uses Bayesian mathematics rather than heuristics, it is AI-1 but not AI-2. If we write a rule-based program to generate parsers for precedence grammars using heuristics, it will be AI-2 but not AI-1 because the problem has a known algorithmic solution.

Although it is possible for work to satisfy both definitions, the best AI-1 work that I have seen does not use heuristic or rule-based methods. Workers in AI-1 often use traditional engineering and scientific approaches. They study the problem, its physical and logical constraints, and write a program that makes no attempt to mimic the way that people say they solve the problem.

III. What can we learn from AI that will help us build the battle-management computer software?

I have seen some outstanding AI-1 work. Unfortunately, I cannot identify a body of techniques or technology that is unique to this field. When one studies these AI-1 programs one finds that they use sound scientific approaches, approaches that are also used in work that is not called AI. Most of the work is problem specific, and some abstraction and creativity are required to see how to transfer it. People speak of AI as if it were some magic body of new ideas. There is good work in AI-1 but nothing so magic it will allow the solution of the SDI battle-management problem.

I find the approaches taken in AI-2 to be dangerous and much of the work misleading. The rules that one obtains by studying people turn out to be inconsistent, incomplete, and inaccurate. Heuristic programs are developed by a trial and error process in which a new rule is added whenever one finds a case that is not handled by the old rules. This approach usually yields a program whose behavior is poorly understood and hard to predict. AI-2 researchers accept this evolutionary approach to programming as normal and proper. I trust such programs even less than I trust unstructured conventional programs. One never knows when the program will fail.

On occasion I have had to examine closely the claims of a worker in AI-2. I have always been disappointed. On close examination the heuristics turned out to handle a small number of obvious cases but failed to work in general. The author was able to demonstrate spectacular behavior on the cases that the program handled correctly. He marked the other cases as extensions for future researchers. In fact, the techniques being used often do not generalize and the improved program never appears.

IV. What about expert systems?

Lately we have heard a great deal about the success of a particular class of rule-based systems known as expert systems. Every discussion cites one example of such a system that is being used to solve real problems by people other than its developer. That example is always the same—a program designed to find configurations for VAX computers. To many of us, that does not sound like a difficult problem; it sounds like the kind of problem that is amenable to algorithmic solution because VAX systems are constructed from well-understood, well-designed components. Recently I read a paper that reported that this program had become a maintenance nightmare. It was poorly understood, badly structured, and hence hard to change. I have good reason to believe that it could be replaced by a better program written using good software engineering techniques instead of heuristic techniques.

SDI presents a problem that may be more difficult than those being tackled in AI-1 and expert systems. Workers in those areas attack problems that now require human expertise. Some of the problems in SDI are in areas where we now have no human experts. Do we now have humans who can, with high reliability and confidence, look at missiles in ballistic flight and distinguish warheads from decoys?

V. Conclusion

Artificial intelligence has the same relation to intelligence as artificial flowers have to flowers. From a distance they may appear much alike, but when closely examined they are quite different. I don't think we can learn much about one by studying the other. AI offers no magic technology to solve our problem. Heuristic techniques do not yield systems that one can trust.

Can automatic programming solve the SDI software problem?

I. Introduction

Throughout my career in computing I have heard people claim that the solution to the software problem is automatic programming. All that one has to do is write the specifications for the software, and the computer will find a program. Can we expect such technology to produce reliable programs for SDI?

II. Some perspective on automatic programming

The oldest paper known to me that discusses automatic programming was written in the 1940s by Saul Gorn when he was working at the Aberdeen Proving Ground. This paper, entitled "Is Automatic Programming Feasible?" was classified for a while. It answered the question positively.

At that time, programs were fed into computers on paper tapes. The programmer worked the punch directly and actually looked at the holes in the tape. I have seen programmers "patch" programs by literally patching the paper tape.

The automatic programming system considered by Gorn in that paper was an assembler in today's terminology. All that one would have to do with his automatic programming system would be to write a code such as CLA, and the computer would automatically punch the proper holes in the tape. In this way, the programmer's task would be performed automatically by the computer.

In later years the phrase was used to refer to program generation from languages such as IT, FORTRAN, and ALGOL. In each case, the programmer entered a specification of what he wanted, and the computer produced the program in the language of the machine.

In short, automatic programming always has been a euphemism for programming with a higher-level language than was then available to the programmer. Research in automatic programming is simply research in the implementation of higher-level programming languages.

III. Is automatic programming feasible? What does that mean?

Of course automatic programming is feasible. We have known for years that we can implement higher-level programming languages. The only real question was the efficiency of the resulting programs. Usually, if the input "specification" is not a description of an algorithm, the resulting program is woefully inefficient. I do not believe that the use of nonalgorithmic specifications as a programming language will prove practical for systems with limited computer capacity and hard real-time deadlines. When the input specification is a description of an algorithm, writing the specification is really writing a program. There will be no substantial change from our present capability.

IV. Will automatic programming lead to more reliable programs?

The use of improved languages has led to a reduction in the amount of detail that a programmer must handle and hence to an improvement in reliability. However, extant programming languages, while far from perfect, are not that bad. Unless we move to nonalgorithmic specifications as an input to these systems, I do not expect a drastic improvement to result from this research.

On the other hand, our experience in writing nonalgorithmic specifications has shown that people make mistakes in writing them just as they do in writing algorithms. The effect of such work on reliability is not yet clear.

V. Will automatic programming lead to a reliable SDI battle-management system?

I believe that the claims that have been made for automatic programming systems are greatly exaggerated. Automatic programming in a way that is substantially different from what we do today is not likely to become a practical tool for real-time systems like the SDI battle-management system. Moreover, one of the basic problems with SDI is that we do not have the information to write specifications that we can trust. In such a situation, automatic programming is no help at all.

Can program verification make the SDI software reliable?

I. Introduction

Programs are mathematical objects. They have meanings that are mathematical objects. Program specifications are mathematical objects. Should it not be possible to prove that a program will meet its specification? This has been a topic of research now for at least 25 years. If we can prove programs correct, could we not prove the SDI software correct? If it was proved correct, could we not rely on it to defend us in time of need?

II. What can we prove?

We can prove that certain small programs in special programming languages meet a specification. The word *small* is a relative one. Those working in verification would consider a 500-line program to be large. In discussing SDI software, we would consider a 500-line program to be small. The programs whose proofs I have seen have been well under 500 lines. They have performed easily defined mathematical tasks. They have been written without use of side effects, an important tool in practical programs.

Proofs for programs such as a model of the earth's gravity field do not have these properties. Such programs are larger; their specifications are not as neat or mathematically formalizable. They are often written in programming languages whose semantics are difficult to formalize. I have seen no proof of such a program.

Not only are manual proofs limited to programs of small size with mathematical specifications; machine theorem provers and verifiers are also strictly limited in the size of the program that they can handle. The size of programs that they can handle is several orders of magnitude different from the size of the programs that would constitute the SDI battle-management system.

III. Do we have the specifications?

In the case of SDI we do not have the specifications against which a proof could be applied. Even if size were not a problem, the lack of specifications would make the notion of a formal proof meaningless. If we wrote a formal specification for the software, we would have no way of proving that a program that satisfied the specification would actually do what we expected it to do. The specification itself might be wrong or incomplete.

IV. Can we have faith in proofs?

Proofs increase our confidence in a program, but we have no basis for complete confidence. Even in pure mathematics there are many cases of proofs that were published with errors. Proofs tend to be reliable when they are small, well polished, and carefully read. They are not reliable when they are large, complex, and not read by anyone but their author. That is what would happen with any attempt to prove even a portion of the SDI software correct.

V. What about concurrency?

The proof techniques that are most practical are restricted to sequential programs. Recent work on proofs of systems of concurrent processes has focused on message-passing protocols rather than processes that cooperate using shared memory. There are some techniques that can be applied with shared memory, but they are more difficult than proofs for sequential programs or proofs for programs that are restricted to communication over message channels.

VI. What about programs that are supposed to be robust?

One of the major problems with the SDI software is that it should function with part of its equipment destroyed or disabled by enemy action. In 20 years of watching attempts to prove programs correct, I have seen only one attempt at proving that a program would get the correct answer in the event of a hardware failure. That proof made extremely unrealistic assumptions. We have no techniques for proving the correctness of programs in the presence of unknown hardware failures and errors in input data.

VII. Conclusion

It is inconceivable to me that one could provide a convincing proof of correctness of even a small portion of the SDI software. Given our inability to specify the requirements of the software, I do not know what such a proof would mean if I had it.

Is SDIO an efficient way to fund worthwhile research?

The subject of this section is not computer science. Instead, it discusses an issue of concern to all modern scientists: the mechanism that determines what research will be done. These remarks are based on nearly 20 years of experience with DoD funding as well as experience with other funding mechanisms in several countries.

I. The proposal

In several discussions of this problem, I have found people telling me they knew the SDIO software could not be built but felt the project should continue because it might fund some good research. In this section I want to discuss that point of view.

II. The moral issue

There is an obvious moral issue raised by this position. The American people and their representatives have been willing to spend huge amounts of money on this project because of the hope that has been offered. Is it honest to take the attitude expressed above? Is it wise to have our policymakers make decisions on the assumption that such a system might be possible? I am not an expert on moral or political issues and offer no answers to these questions.

III. Is DoD sponsoring of software research effective?

I can raise another problem with this position. Is the SDIO an effective way to get good research done? Throughout many years of association with DoD I have been astounded at the amount of money that has been wasted on ineffective research projects. In my first contact with the US Navy, I watched millions of dollars spent on a wild computer design that had absolutely no technical merit. It was abandoned many years after its lack of merit became clear. As a consultant for both the Navy and a number of contractors, I have seen expensive software research that produces very large reports with very little content. I have seen those large, expensive reports put on shelves and never used. I have seen many almost identical efforts carried out independently and redundantly. I have seen talented professionals take approaches that they considered unwise because their "customers" asked for it. I have seen their customers take positions they do not understand because they thought that the contractors believed in them.

In computer software, the DoD contracting and funding scheme is remarkably ineffective because the bureaucrats who run it do not understand what they are buying.

IV. Who can judge research?

The most difficult and crucial step in research is identifying and defining the problem. Successful researchers are usually those who have the insight to find a problem that is both solvable and important.

For applied research, additional judgment is needed. A problem may be an important one in theory, but there may be restrictions that prevent the use of its solution in practice. Only people closely familiar with the practical aspects of the problem can judge whether or not they could use the results of a research project.

Applied research must be judged by teams that include both successful researchers and experienced system engineers. They must have ample opportunity to meet, be fully informed, and have clearly defined responsibilities.

V. Who judges research in DoD?

Although there are a few notable exceptions within DoD, the majority of those who manage its applied research program are neither successful researchers nor people with extensive system-building experience. There are outstanding researchers who work for DoD, but most of them work in the laboratories, not in the funding agencies. There are many accomplished system builders who work for DoD, but their managers often consider them too valuable to allow them to spend their time reviewing research proposals. The people who end up making funding decisions in DoD are very often unsuccessful researchers, unsuccessful system builders, and people who enter bureaucracy immediately after their education. We call them technocrats.

Technocrats are bombarded with weighty volumes of highly detailed proposals that they are ill prepared to judge. They do not have the time to study and think; they are forced to rely on the advice of others. When they look for advice, they look for people that they know well, whether or not they are people whose areas of expertise are appropriate, and whether or not they have unbiased positions on the subject.

Most technocrats are honest and hard-working, but they are not capable of doing what is needed. The result is a very inefficient research program. I am convinced that there is now much more money being spent on software research than can be usefully spent. Very little of the work that is sponsored leads to results that are useful. Many useful results go unnoticed because the good work is buried in the rest.

VI. The SDIO

The SDIO is a typical organization of technocrats. It is so involved in the advocacy of the program that it cannot judge the quality of the research involved.

The SDIO panel on battle-management computing contains not one person who has built actual battle-management software. It contains no experts on trajectory computations, pattern recognition, or other areas critical to this problem. All of its members stand to profit from continuation of the program.

VII. Alternatives

If there is good research being funded by SDIO, that research has an applicability that is far broader than the SDI itself. It should be managed by teams of scientists and engineers as part of a well-organized research program. There is no need to create a special organization to judge this research. To do so is counterproductive. It can only make the program less efficient.

VIII. Conclusion

There is no justification for continuing with the pretense that the SDI battle-management software can be built just to obtain funding for otherwise worthwhile programs. DoD's overall approach to research management requires a thorough evaluation and review by people outside the DoD.

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28 June, 1985

Mr. James H. Offut
Assistant Director, BM/C3
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Office of the Secretary of Defense
Washington, D.C.
20301

Dear Mr. Offut:

Thank you for your letter of 5 June 1985 appointing me a member of the SDIO Panel on Computing in Support of Battle Management. I appreciate the recognition implicit in being chosen as one of your expert advisors on computer science.

After attending the first meeting of the panel and giving the problem considerable thought, I am resigning my membership in the panel. I do not believe that further work by the panel will be useful and I cannot, in good conscience, accept further payment for useless effort.

The panel's work will not be useful for two reasons.

1) The goals stated for the Strategic Defense System cannot be attained by the class of systems that you are considering.

2) The SDIO is not the appropriate organization to fund and administer the research it is supporting. Most of the money spent will be wasted. The panel on which you have asked me to serve, is not appropriately constituted, clearly chartered, and adequately informed. There are better ways to select and manage research.

My conclusions are not based on political or policy judgements. Unlike many other academic critics of the SDI effort, I have not, in the past, objected to defense efforts or defense sponsored research. I have been deeply involved in such research and have consulted extensively on defense projects. My conclusions are based on more than 20 years of research on software engineering including more than 8 years of work on real-time software used in military aircraft. They are based on familiarity with both operational military software and computer science research. My conclusions are based on characteristics peculiar to this particular effort, not objections to weapons development in general.

Before making my decision and writing this letter I have carefully reconsidered what I have learned in my own research area and I have reviewed reports of work in related fields. These reviews lead inevitably to the judgements stated above. I am willing to stake my professional reputation on my conclusions.

Enclosed with this letter are several brief papers (1 - 2 pages each) summarizing my observations and substantiating the conclusions stated above. Their purpose is to explain my decision.

These papers explain:

1) The fundamental technological differences between software engineering and other areas of engineering and why software is unreliable,

2) The properties of the proposed SDI software that make it unattainable,

3) Why the techniques commonly used to build military software are inadequate for this job,

4) The nature of research in Software Engineering, and why the improvements that it can effect will not be sufficient to allow construction of a truly reliable strategic defense system,

5) The nature of research in Artificial Intelligence, and why I do not expect it to help in building reliable military software,

6) The history of research in Automatic Programming, and why I do not expect it to bring about the substantial improvements that are needed,

7) Why Program Verification cannot give us a reliable strategic defense battle management software system,

8) My opinions on the management of applied research, why I consider this panel and the SDIO in general to be an inappropriate vehicle for funding research, and what I would do instead.

I am quite certain that you will be able to find software experts who disagree with my conclusions. For many, the project offers a source of funding, funding that will enrich some personally, while offering others new and generous support for their personal research projects. During the first sittings of our panel, I could see the dollar figures dazzling everyone involved. Almost everyone that I know within the military industrial complex sees in the SDI a new "pot of gold" just waiting to be tapped.

For others, the project offers an unending set of technological puzzles that are fun to work on; such problems are exciting and challenging whether or not the work ever produces useful results. Almost every software expert that I know, entered the field because they enjoy this kind of challenge. Several of the speakers at the first meeting of our panel could not hide their delight at the unbounded set of technical challenges implicit in the unattainable goals of the project.

I can tell you, as one who likes both money and technical challenges, that these temptations are very hard to resist. You will find it very hard to find unbiased expert opinions on this issue.

In March 1983 the President asked us, as members of the scientific community, to provide the means of rendering nuclear weapons impotent and obsolete. I believe that it is our duty, as scientists and engineers, to reply that we have no technological magic that will accomplish that. The short term applied research and focussed development that SDI is now funding is not going to solve the problem; the President and the public should know that.

Yours truly,

David L. Parnas
Lansdowne Professor

DLP:jcs

Cc: S. Wilson, panel members

Why Communications Systems Are Not Like SDI

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1. Introduction

Recently SDIO, and its advisors, have chosen to use the AT&T network and ARPANET communications as evidence that SDI software could be successful. This paper explains why those comparisons are not relevant. It shows that the two systems cited do not have the properties that I described in the papers submitted with my resignation from the SDIO panel on Computing in Support of Battle Management. The testimony of the SDIO advisors does not refute the arguments that I made months ago.

2. The "old reasons"

In [1] I listed six properties of SDI that differentiated it from other large software systems. Five of these were summarized in my testimony on 3 December 1985. For the convenience of the reader, I will repeat each property and then explain why communications networks do not have that property. Quotations from my written testimony are in italics.

a. SDI software must be based on assumptions about target and decoy characteristics, which are controlled by the opponent. We cannot rely upon our information about them. The dependence of any program on those assumptions is a rich source of effective countermeasures. Espionage could render the whole multi-billion dollar system worthless without our knowledge.

All equipment connected to either AT&T equipment or ARPANET must meet strict specifications and may be disconnected if it is not. Those systems are not expected to work with equipment deliberately designed to defeat them.

b. In space, the redundancy required for high reliability is unusually expensive. The dependence of SDI on communicating computers in space, makes it unusually vulnerable. High reliability can be achieved only if failures of individual components are statistically independent; for a system subject to coordinated attacks, that is not true.

Both ARPANET and AT&T systems make heavy use of land-based redundancy. Both achieve reliability only in the absence of coordinated attacks on their components. Neither should be expected to provide service during such attacks.

c. Programs that reliably meet strict real-time deadlines are based on built-in schedules, computed in advance. For SDI, schedules must be based on assumptions about the structure of an attack. Those assumptions allow countermeasures that will overload the system - causing it to either fail completely or ignore some of the objects it is tracking. Because every computer system has finite limits, overloading is always available as a countermeasure.

Except at the lowest level, network communications systems make ample use of buffering and allow delays in establishing connections and transporting messages. Such delays would not be acceptable in systems that must process signals in real-time in order to aim and fire weapons with pinpoint accuracy.

The overload response for communications systems is discussed in more detail below.

d. Realistic testing of the integrated hardware and software is impossible. Many potential problems would not be revealed by component testing, simulations, or small scale field tests.

Communications systems can be tested as a whole with live or recorded real data. Even satellite communications software can be tested on the ground using simulated noise. At AT&T such tests are called "soaks" and are standard procedure.

e. Unlike other weapon systems, there will be no opportunity to modify the software during or after its first battle. It must work the first time.

All of our reliable communications software has been improved in use. In the case of ARPANET some of the recent "improvements" have caused network-wide service disruptions.

3. Why program size is not a good measure of problem complexity.

One property that the AT&T software does share with SDI software is large size. In my resignation papers I put relatively little emphasis on the size of a program. Firstly, SDI size estimates are almost meaningless in the absence of architectural decisions. Second, in making comparisons of software sizes, it is important to know what is included. Estimates for the AT&T network include much "off-line" and non-critical software such as billing programs.

Most important, we know that the size of a program is a very poor indicator of the complexity of the problems that it solves. For example, researchers at Bell Labs have demonstrated that most of the functions performed by Professor Brooks' giant product, OS/360, can be performed, often better, by a much smaller program. The size of the current AT&T software collection is much more a function of the historical development of the network than of the inherent difficulty of the problem.

4. A better measure of problem complexity

While program size is not a good measure of problem complexity, we should consider another. One relevant view is the size and structure of the state space that must be modeled. Because of the fact that information is digitized before it enters a communications network, and the interfaces to the software are strictly controlled, the state space is relatively small. In well designed communications systems there is exploitable regularity. We are able to validate designs for programs with such state spaces.

In contrast, weapon systems must deal with a physical world with an infinite state. The systems deal with a finite approximation of the infinite state space. The number of states is huge, and there is little regular structure. We have not been able to validate such programs.

5. Overload management

Communications systems are designed with a fixed capacity on the understanding that excess workload will be dropped or rejected. All systems have such limits. The SAFEGUARD system built by AT&T took a similar policy; it would ignore new missiles if it had reached its capacity. We can live with such a policy for civilian communications systems. Unfortunately, these limits provide easy countermeasures to any missile defense system. A decoy does not have to be a good imitation to overload the computers. As we know from dealing with counterfeit money, it takes time to detect even poor fakes.

6. Error handling and error confinement

SDIO panelists suggest that we can obtain reliability in error prone systems by using redundant facilities, error checking, and error handling procedures similar to those I have used and advocated in print for 13 years. My recent work with a military real-time system has shown me that these ideas have limited applicability for such systems. They introduce delays and resource contention that cause systems with hard real-time deadlines to fail. For SDI, the old hunting adage "a miss is as good as a mile", is quite relevant. Moreover, error recovery techniques, like all redundancy approaches, are of little value when computing components are subject to coordinated attack.

Finally, redundancy techniques are successful in hardware because they must deal with component aging and manufacturing defects, not design errors. Design errors are as likely in the error checking as they are in the rest of the system. In software we have only design errors. A forthcoming paper by Professor N. Leveson, one of the leading researchers in software safety, demonstrates that transferring hardware redundancy techniques to software can be ineffective. The hardware techniques make mathematical assumptions that do not apply to software.

David L. Parnas, December 8, 1985

7. Are communications systems as trustworthy as SDIO panelists would suggest?

There are few regular users of the phone system who have not experienced a failure in the form of calls that are not completed or are suddenly interrupted. We accept such failures as normal and dial again. There is no regular user of the ARPANET who has not experienced lost or delayed messages. Experienced programmers are never surprised by such failures.

More important, there have been major disruptions in both systems. In January 1981 failure of a single component brought most of the ARPANET to a halt. The error recovery messages jammed the system. About the same time, a major switch in the AT&T system failed for more than an hour because of design error that "survived" all the predeployment tests and more than a year of use.

Such behavior is acceptable in civilian communications, but similar events in SDI during an attack, would be catastrophic.

8. Conclusions

SDIO representatives are correct when they claim that communications systems meet their requirements, but it is ridiculous to suggest, on that basis, that the SDI requirements can be met. The requirements are too different.

When I decided that the SDI software could never be trustworthy, I provided a detailed justification for my position. All of the properties discussed in section 2 of this paper were discussed, at greater length, in July. The only "rebuttal" offered by SDIO is to cite systems that do not have the properties that I stated to be critical. It is as if I had not explained my position or they had not read my explanation. Citing such systems as counterexamples is an attempt to evade, rather than find, the truth.

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The Development of Software for Ballistic-Missile Defense

What some call a "Star Wars" defense would depend on computers to control an unprecedentedly complex array of weapon systems. Developing reliable software for such a defense may be impossible

by Herbert Lin

"The ultimate goal of the Strategic Defense Initiative (SDI) is to eliminate the threat posed by nuclear ballistic missiles," according to the interim charter of the Strategic Defense Initiative Organization. To achieve the goal of comprehensive defense, the organization is empowered by the Department of Defense to manage research programs that examine the feasibility of developing technology for a ballistic-missile defense (BMD) to protect cities and military assets. Such a defense would destroy or incapacitate nuclear-warhead delivery systems on the way to their targets. A wide variety of defensive weapons might be employed. They include lasers, particle beams, electromagnetic railguns and nonexplosive "kinetic kill" vehicles.

The Strategic Defense Initiative Organization recognizes that the computer technology that would control individual weapons and coordinate their operation is of comparable importance to the development of the critical new interception technologies. The command-and-control system for a comprehensive ballistic-missile defense must be capable of flawlessly receiving and acting on information pertaining to thousands of missile launches, tens of thousands of warheads and hundreds of thousands of decoys. It must do all this within the half hour it would take for an intercontinental ballistic missile (ICBM) to travel from a launch site in the Soviet Union to a target in the U.S. Because the system must be highly automated, there would be virtually no time for human intervention to correct unexpected failures. For the most part the execution of a computer program would replace human decision making once the BMD system was engaged.

Before the U.S. makes a serious effort to develop software for such a system, three questions should be considered. What is the nature of a BMD system? What are the obstacles to BMD software development? Can these obstacles be circumvented?

The comprehensive defense system most often discussed by Strategic Defense Initiative Organization officials (and the system's critics) consists of four tiers. That is, the ballistic-missile defense would attack hostile missiles in each of the four phases of their flight. The phases are the boost phase, during which a multistage launch vehicle carries the payload through the atmosphere; the postboost phase, during which nuclear warheads in reentry vehicles and "penetration aids" such as decoys are sequentially released above the earth's atmosphere by a maneuverable "bus"; the midcourse phase, during which the reentry vehicles and decoys traverse the greater part of their trajectory, and the terminal phase, during which the warheads in their reentry vehicles penetrate the atmosphere and detonate at their assigned targets.

A four-tiered ballistic-missile defense gives the interceptors several opportunities to destroy the offensive weapons. Within each tier a defensive system must successfully detect and track targets before it can destroy them [see "Space-based Ballistic-Missile Defense," by Hans A. Bethe, Richard L. Garwin, Kurt Gottfried and Henry W. Kendall; SCIENTIFIC AMERICAN, October, 1984]. Computers and appropriate software are needed to coordinate operation of the defense and evaluate its effectiveness. This coordination process is called battle management. Although experts are still undecided as to how a battle-management system should be organized, a hypothetical structure might include "local" computers and software that are responsible for battle management within each defensive tier. Each tier's system would then be connected with the other tiers through a global battle-management system.

The software guiding battle management within a given defensive tier would control the local sensors and weapons. These sensors would locate and track potential targets and distinguish actual targets from decoys. This part of the software might create a "track file" that contains all the known information about each target. The software could then allocate defensive resources in a specific tier by coordinating the track-file information with the available weapons and the programmed rules of engagement, rules that determine under what circumstances targets are to be attacked. The global battle-management system would assess the extent and nature of an attack in progress and specify the rules of engagement for each tier. In order to prepare a local battle-management system to engage warheads that have leaked through preceding tiers, the global system might pass on track-file and sensor information obtained in the boost-phase tier to each succeeding defensive tier.

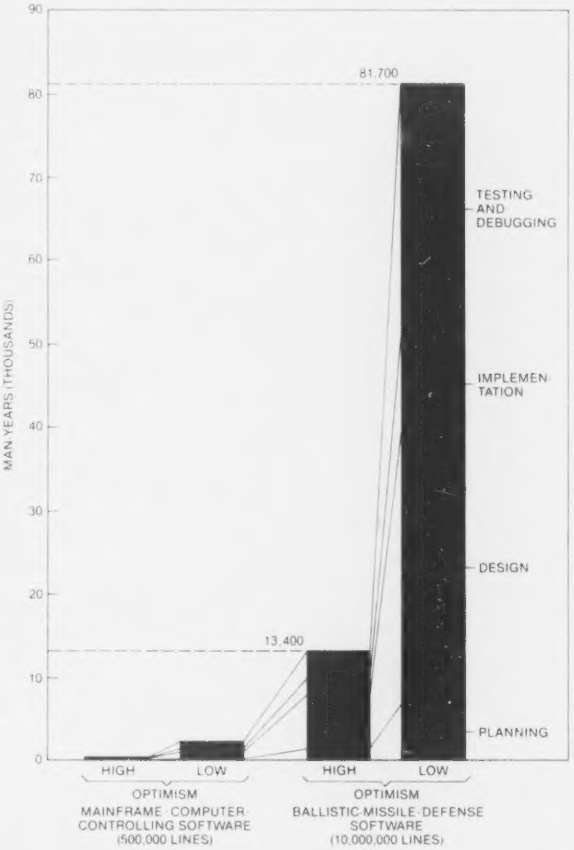
A ballistic-missile defense depends heavily on the software controlling it; defective software might lead to failure. Hence software development is a critical factor in attaining the objectives for which the system is designed.

Software development is an intellectual process that can be divided into distinct conceptual phases. These include planning, design, implementation, testing and debugging. In actual software-development projects the phases are not always carried out sequentially; for example, plans can change after a project has begun. Consequently developers may have to redesign a piece of software.

The first crucial area of software development is planning: the developer needs to determine what functions the software is to perform and to envision the different situations to which the software must respond. Specification, or deciding what action should be taken and at what time, becomes more difficult as a task grows in complexity. A simple example from everyday life makes the point. If the task is to count the number of people in a small audience, it is intuitively obvious how to proceed. If the audience consists of tens of thousands of people in a football stadium, the counting task requires much greater elaboration. For example, what defines the boundary of the stadium? How does one define a person? (Should the fetus in a pregnant woman be counted as a person?) Clearly, factors that appear infrequently and are therefore irrelevant in the first case may complicate the specification of a task as it grows in size.

The precise specification of what a ballistic-missile defense must do is a complicated task. For instance, the statement "Shoot down all Soviet missiles" is sufficient if the world contains only Soviet missiles and every Soviet missile should be shot down under all circumstances. But the world is not so simple. How can Soviet missiles be distinguished from non-Soviet missiles? What if a Soviet missile is headed for a target in East Germany? While these questions only scratch the surface of specification, they broach a fundamental problem developers will encounter, namely that it is often difficult to decide whether some particular aspect of a program is desirable or undesirable.

Moreover, developers will need to accurately predict every contingency and then decide how the software should respond to each. For instance, what procedures should the software follow if the computers in one defensive tier's battle-management system fail? How might a ballistic-missile defense differentiate a Soviet space-shuttle launch from that of a Soviet ICBM? Because of the nearly infinite number of possibilities, developers will be hard pressed to foresee all possible circumstances. Simply writing out all situations a BMD system might have to face and the appropriate actions to be taken in each case might plausibly require tens of thousands of pages. In comparison the U.S. Tax Code, which is the



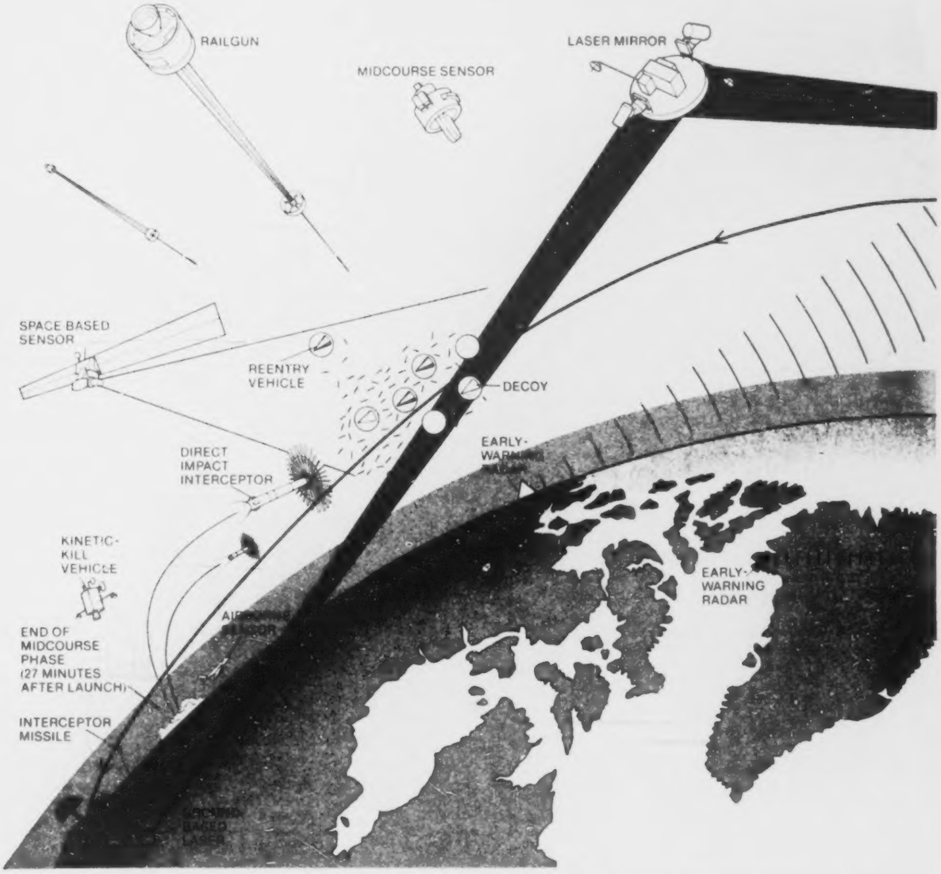
LEVEL OF EFFORT required for each of four stages in the development of software for a ballistic-missile defense (which would amount to some 10 million lines of programming code according to a Government study) is contrasted with the effort needed to produce the controlling software for a mainframe computer (500,000 lines of code). The stages are not strictly sequential; in actuality there is some overlap. Also, the final stage refers to testing and debugging before the product is delivered; once the system is "on line" further testing and debugging would be necessary. For each software-development project the bar at the left represents estimates based on highly optimistic assumptions; the bar at the right represents estimates based on less optimistic assumptions. The scaling function relating level of effort to program size is taken from *Software Engineering Economics*, by Barry W. Boehm.

legislative specification for Federal tax law, fills about 3,000 pages. The possibility that all potential scenarios would be adequately accounted for in the specification of the BMD software is at least as unlikely as the possibility that no unanticipated loopholes exist in the Federal tax laws.

Two examples may serve as further illustration. First, on June 3, 1980, the North American Aerospace Defense Command (NORAD) reported that the U.S. was under missile attack. The report was traced to a faulty computer circuit that generated incorrect signals. If the developers of the software responsible for processing these signals had taken into account the possibility that the circuit could fail, the false alert might not have occurred.

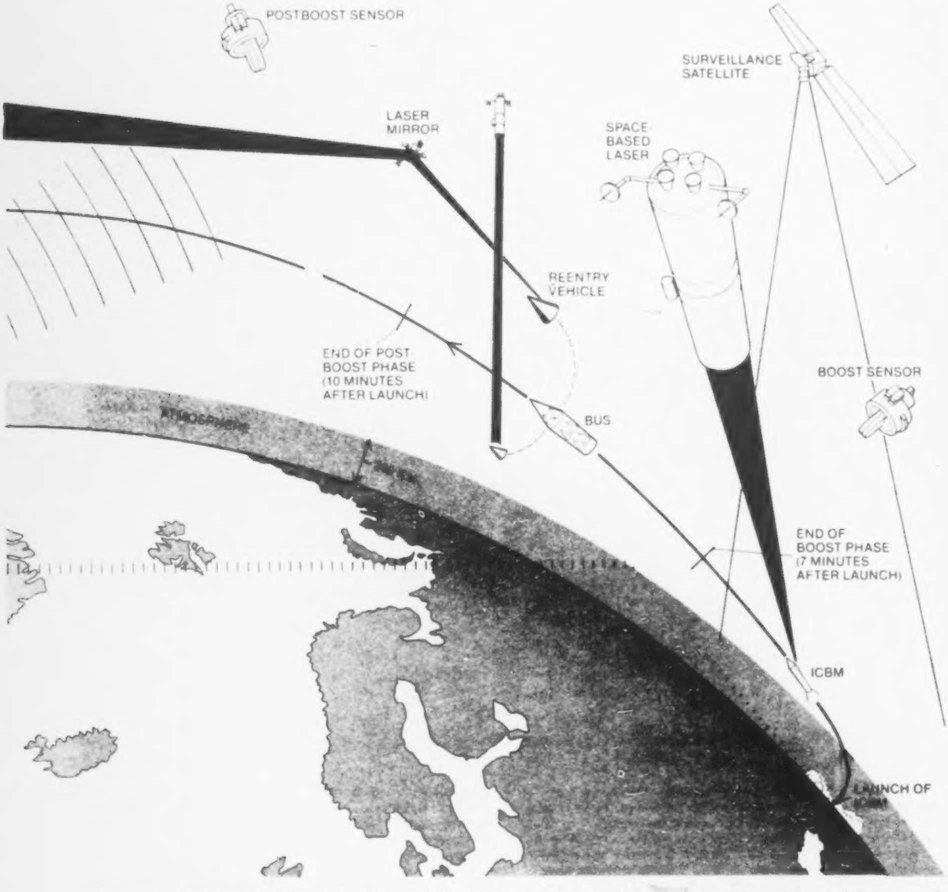
A second example, involving the sinking of the British destroyer H.M.S. *Sheffield*, came to light in the aftermath of the Falkland Islands war. According to one report, the ship's radar warning systems were programmed to identify the Exocet missile as "friendly" because the British arsenal includes the Exocet. As a result the system ignored the transmissions of a hostile Exocet's homing device and allowed the missile to reach its target, namely the *Sheffield*.

The design phase of software development is also rife with potential problems. In this phase developers ask how the specifications that emerged from the planning stage can be imple-


RAILGUN
LASER MIRROR
MIDCOURSE SENSOR
SPACE BASED SENSOR
REENTRY VEHICLE
DECOY
EARLY-WARNING RADAR
DIRECT IMPACT INTERCEPTOR
KINETIC-KILL VEHICLE
EARLY-WARNING RADAR
AIRBORNE SENSOR
END OF MIDCOURSE PHASE (27 MINUTES AFTER LAUNCH)
INTERCEPTOR MISSILE
GROUND-BASED LASER

PROPOSED HARDWARE for a ballistic-missile-defense system includes an assortment of intercepting weaponry: high-powered lasers (based in space or on the ground), railguns and missiles. In addition satellite, airborne and ground-based sensors would be needed. Enemy ballistic missiles would be engaged in every phase of their trajectory: the boost phase, during which the missile is under powmented through computers. Developers conceive the algorithms that must be incorporated into the software, the sequence certain actions are to follow, and so on. Conceptually the design phase resembles the task confronting an architect who must draw the blueprints for a house after the requirements have been determined. If the architect incorrectly assesses the ability of the surrounding land to carry off water, the basement can flood, causing damage that is expensive to repair. Similarly, design errors in software development, if not caught in the design phase, can be expensive to correct.

Important software systems have not been exempt from design errors. For example, the manned space capsule *Gemini V* missed its landing point by 100 miles because its guidance program ignored the motion of the earth around the sun. In another case five nuclear reactors were shut down temporarily because a program testing their resistance to earthquakes used an arithmetic sum of variables instead of the square root of the sum of the squares of the variables. The lesson is that neither the nature nor the frequency of planning and design errors is predictable; indeed, these errors can be eliminated only if analysts can perceive them beforehand, a task that becomes more demanding as system size or complexity increases. Detecting and correcting errors is therefore a fundamental aspect of any software-development project. How then can errors


POSTBOOST SENSOR
SURVEILLANCE SATELLITE
LASER MIRROR
SPACE-BASED LASER
REENTRY VEHICLE
END OF POST-BOOST PHASE (10 MINUTES AFTER LAUNCH)
BOOST SENSOR
BUS
ATMOSPHERE
END OF BOOST PHASE (7 MINUTES AFTER LAUNCH)
ICBM
LAUNCH OF ICBM

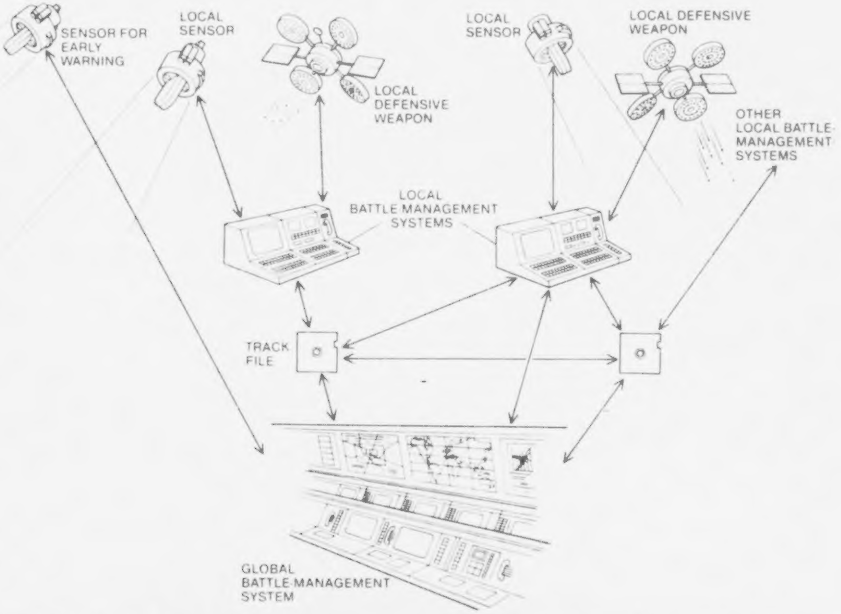
ered flight in the atmosphere; the postboost phase, during which reentry vehicles (equipped with nuclear warheads), decoys and obscuring metallic chaff are released; the midcourse phase, during which the various objects travel the major part of their course in space, and the terminal phase, during which the reentry vehicles penetrate the atmosphere to detonate over their respective targets.

be found and confidence in the operation of the system be assessed?

Two techniques are effective for assessing the trustworthiness of a software system. One technique is analytical. It requires that the program's correctness be proved by mathematically certifying that its output conforms to certain formally specified criteria when expected input data are received. Although proofs of program correctness help to ensure that a software system meets its theoretical specifications, they do not ensure that the system will fulfill its mission. Complete proofs are at least comparable in size to the programs they are trying to verify; analysts are thus faced with understanding a proof that is as complicated as the program itself. A program proof cannot guarantee the amount of time it will take for a system to complete "real-time computations" (a critical factor that will be discussed below), nor can it reveal the nature of the output when the system receives unanticipated input data. Finally, proofs of correctness cannot provide any promise that the actual program specifications themselves are correct.

A more important assessment technique is empirical testing. Clearly a ballistic-missile defense cannot be subjected to a large-scale empirical test under realistic conditions. The cost of such a test would be staggering. Of greater concern, however, is the fact that the Soviet Union could not confidently distinguish between the launching of a large number of test missiles and an actual U.S. nuclear attack. System developers must therefore fall back on more limited types of empirical testing: small-scale testing, in which a BMD system would be tested against a few missiles, and simulation testing, in which a computer would mimic large-scale threats to the targets a BMD system protects. Some experts maintain that such tests make actual large-scale ones unnecessary. Although such tests do increase confidence, they cannot ensure that the mission of a comprehensive ballistic-missile defense will be accomplished.

Problems that arise from integrating individual components into an effective system often appear only when the complete system is tested near its limits, something that cannot be done in small-scale tests. A case in point is the World Wide Military Command and Control System (WWMCCS), a communication network used by civilian and military authorities to coordinate and transmit information to and from U.S. military forces in the field. During routine operations, when the message



COMMUNICATION LINKS between sensors, weapons and computers are crucial in a ballistic-missile-defense (BMD) battle-management system. The sensors and weapons that constitute a "layer" of defense would be placed under the control of a "local" battle-management computer. Such a battle-management system would locate and track potential targets, identify actual targets among the debris and decoys, assign its weapons to specific targets at specific times and assess whether the target was successfully destroyed. All relevant information concerning the targets that have been engaged would then be placed on a "track file" and passed on to the next local battle-management system as well as a global battle-management system. The global system would be in constant communication with all local systems. For each of them it would specify the precise circumstances under which given targets could be attacked, transmit track-file information and coordinate actions to protect the BMD system itself. In addition the global battle-management computer would receive the first warning that an attack was under way. The network diagrammed here could be severely disrupted by an attack on the single vertex: the global battle-management system. Such vulnerability could be minimized through redundancy.

traffic is low, the WWMCCS has performed satisfactorily. When the message traffic is high, however, the performance of the system has suffered. In a 1977 exercise, when it was connected to the command-and-control systems of several regional commands, the WWMCCS had an average success rate for message transmission of only 38 percent.

As a way of overcoming the limitations of small-scale testing, developers often rely on simulators to create likely attack scenarios. Although simulation provides information beyond that achieved by small-scale testing alone, the technique, as applied to the testing of a ballistic-missile defense, is restricted in several ways. First, simulators may not be able to reproduce the "signatures," or parameters, of the physical phenomena associated with various events, such as simultaneous nuclear explosions, rapidly and accurately enough to test the responsiveness of the defense system. Analysts must therefore rely on assumptions about the signatures of each event they choose to simulate; that is, events are "preprocessed" before they are fed into the defense system. As a result of using preprocessed data, there can be no surprises during the simulation that might test how the system reacts to circumstances not anticipated by developers, and so the realism of the test is diminished.

Although advances in computer technology have greatly increased the computational speed of computers, and thereby facilitated the design of simulators that can model more realistic environments, increased speed will not help to simulate data on physical phenomena for which theoretical and empirical understanding is inadequate. For instance, given present knowledge, scientists would not be able to model accurately the simultaneous explosion of several closely spaced nuclear weapons under certain conditions. More important, simulators cannot satisfactorily duplicate all plausible attacks, since a determined and clever opponent ultimately chooses the parameters of an actual attack. Consequently any confidence in a BMD system that is based on simulated tests rests on the assumption that those responsible for the simulation can predict and reproduce in electronic form the range of tactics to which an enemy might resort.

The story of the Aegis air-defense system illustrates the limitations of simulation testing. The battle-management system for Aegis is designed to track hundreds of airborne objects in a 300-kilometer radius and then allocate enough weapons to destroy about 20 targets within the range of its defensive missiles [see "Smart Weapons in Naval Warfare," by Paul F. Walker; SCIENTIFIC AMERICAN, May, 1983]. Aegis has been installed on the U.S.S. *Ticonderoga*, a Navy cruiser. After the *Ticonderoga* was commissioned the weapon system underwent its first operational test. In this test it failed to shoot down six out of 16 targets because of faulty software; earlier small-scale and simulation tests had not uncovered certain system errors. In addition, because of test-range limitations, at no time were more than three targets presented to the system simultaneously. For a sizable attack approaching Aegis' design limits the results would most likely have been worse.

Errors are not unexpected in operational tests; indeed, malfunctions are inevitable during the initial shakedown exercise of a new weapon system. By the time of the next Aegis tests, they had been corrected and none recurred. Future exercises will probably uncover additional errors, which will in turn be fixed. Through this process the performance of the Aegis system will gradually improve.

Unlike the performance of Aegis, the performance of a comprehensive ballistic-missile defense against a large-scale attack will not improve with experience. Because large-scale empirical testing is impossible, the first such test for a comprehensive BMD system would be an actual large-scale attack on the U.S. A more complex battle-management system that must keep track of more targets and operate under tighter timing constraints is unlikely to have a better performance record than Aegis has. In addition a severe software failure in a full-blown battle situation would offer little or no opportunity for system designers to learn from the experience.

Nevertheless, developers of a ballistic-missile defense will attempt to improve the system's performance by testing for errors and eliminating them, by expanding software capabilities in response to newly perceived needs and by adding new hardware and concomitant software to the project. These efforts, along with bringing new workers into the project, come under what specialists call software maintenance. It can account for approximately 70 percent of the total life-cycle costs of a software-development project.

Two major maintenance issues are particularly salient in relation to a system for ballistic-missile defense. First and most important, significant errors discovered after the software has been put into operational use must be eliminated. These errors can range from an incorrect coding symbol to a fundamental design flaw. On June 19, 1985, the Strategic Defense Initiative Organization did a simple experiment. The crew of the space shuttle was to position the shuttle so that a mirror mounted on its side could reflect a laser beamed from the top of a mountain 10,023 feet above sea level. The experiment failed because the computer program controlling the shuttle's movements interpreted the information it received on the laser's location as indicating the elevation in nautical miles instead of feet. As a result the program positioned the shuttle to receive a beam from a nonexistent mountain 10,023 nautical miles above sea level. This small procedural error was of little significance to the test itself, however; a second attempt a few days later was successful. Nevertheless, the event shows that even simple errors can lead to mission failure.

Although the bug in the space-shuttle experiment was easily rectified, removing errors from a ballistic-missile defense will require considerably more effort. In particular the battle-management software must receive and process information in such a way as to keep pace with circumstances external to the computer during an attack. That is, the software must run in "real time" [*see illustration on next page*]. One problem with debugging a real-time software package is ascertaining why it may operate with one specific configuration of equipment but not with another that differs only slightly. For example, a certain missile can be currently launched at supersonic speeds by the F-4G Wild Weasel aircraft but not by the F/A-18 Hornet: a software system that works in the F-4G is not entirely compatible with the avionics of the F/A-18.

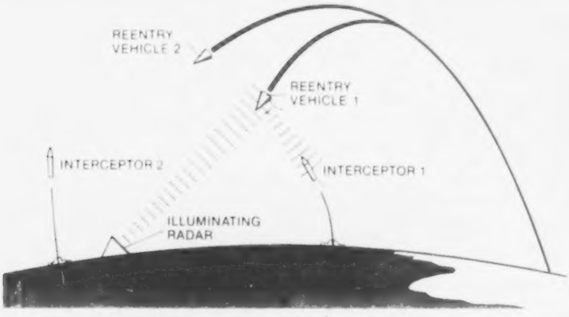
A second problem of particular significance to debugging real-time software is that analysts often find it difficult to make errors recur, something that is essential if bugs are to be located. Real-time output is often determined by factors such as the arrival times of sensor inputs. These determinants of a program's behavior cannot always be reproduced with enough accuracy for the error to be found and eliminated. Indeed, finding an error requires an understanding of the precise circumstances leading to it. Because that is not always possible with large real-time systems, software errors may be identified in practice only in a probabilistic sense. Large computer programs, in fact, usually evolve through a series of incompletely understood changes. After a while the programmer can no longer predict outcomes with confidence; instead he can only hope that the desired outcome will be attained.

There is a final complication to debugging real-time software: even if an error can be located, attempts to eliminate it may not be successful. The probability of introducing an error (or more than one) while eliminating a known error ranges from 15 to 50 percent. Moreover, the majority of software-design errors that appear after software is put into service do so only following extensive operational use. Experience with large control programs (ones consisting of between 100,000 and two million lines of code) suggests that the chance of introducing a serious error in the course of correcting original errors is so large that only a small fraction of the original errors should be remedied.

In the context of a comprehensive ballistic-missile defense, one should therefore ask about the consequences of an error that would manifest itself infrequently and unpredictably. The details of the first operational launch attempt of the space shuttle provide an example. The shuttle, whose real-time operating software is about 500,000 lines of code, failed to take off because of a synchronization problem among its flight-control computers. The software error responsible for the failure, which was itself introduced when another error was fixed two years earlier, would have revealed itself, on the average, once in 67 times.

Aside from detecting and removing errors, a second aspect of software maintenance stands as a hurdle to developing a defensive system: the management of product development. The Defensive Technologies Study Team (DTST), chartered by the Department of Defense to examine the feasibility of a comprehensive ballistic-missile defense, estimates that the entire system will require a minimum of 10 million lines of programming code. In comparison, the entire software system for Aegis is an order of magnitude smaller. If the DTST estimate is low by a factor of only two, even a very optimistic software-development project will entail more than 30,000 man-years of work, or at least 3,000 programmers and analysts working for about 10 years. For this reason the project can expect a staff turnover that will reduce the institutional memory of the project. During staff transitions it is conceivable that an essential detail, such as updating a particular subprogram, could be overlooked. A tragic example of management error occurred in 1979, when an Air New Zealand airliner crashed into an Antarctic mountain; its crew had not been told that the input data to its navigational computer, which described its flight plan, had been changed.

It is also possible that Soviet agents might try to sabotage the project. They could, for instance, deliberately introduce hard-to-find flaws into the system that would become evident during a real attack but not during testing. The possibility that a program might contain some hidden "time bomb" that would cause the software to fail at a critical moment cannot be ignored. The obvious preventive step would be to impose security clearances on a "need to know" basis. Such restrictions, however, would inhibit communication among the staff working on different parts of the system and thereby increase the likelihood of serious, unintentional software errors arising.

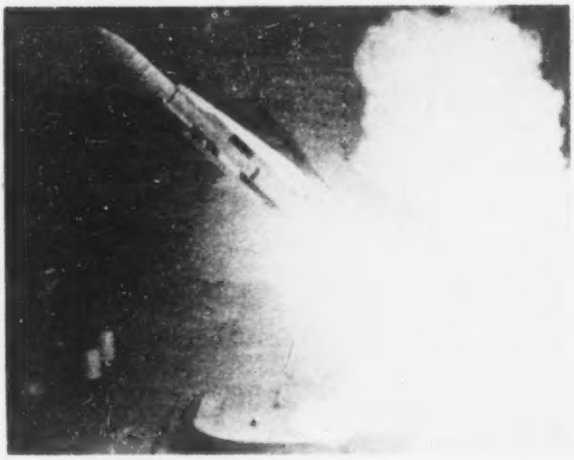


"REAL TIME" SOFTWARE must be executed at a rate defined by the timing of events external to the computer hardware. A computer controlling the radar illumination of an incoming reentry vehicle so that an interceptor missile can home in on the reflected signal would have to maintain the radar beam on the reentry vehicle until the vehicle was destroyed. If the radar were turned away too soon, the interceptor might "lose" its target, particularly if the reentry vehicle were designed to evade approaching interceptors. Yet the computer must re-aim the radar beam so that a second reentry vehicle could also be intercepted. The computer program has to shift the beam to the second vehicle once the first is destroyed, and it must do so quickly enough to enable a second interceptor to reach its target.

Tightening security will not prevent the Soviet Union from thwarting the system by several other means. There is no reason to believe that Soviet officials faced with a U.S. BMD system would not try to disguise the observable characteristics of their ballistic missiles, warheads and decoys during tests or in actual use. Without reliable data on Soviet missiles, U.S. developers cannot be sure the defensive system will work. Furthermore, the Russians may develop new tactics or weapons that would force U.S. analysts to reprogram the battle-management system to meet new threats. Accumulated changes over time would probably result in many unpredictable interactions and could ultimately necessitate a total redesign of the system.

It has been suggested that the development of software for exceedingly complex systems could be facilitated by reliance on "expert systems" and automatic programming. For example, a Defense Advanced Research Projects Agency (DARPA) report stated that expert systems may be applicable to a ballistic-missile defense. Expert systems are detailed descriptions, expressed as computer rules, of the thought processes human experts use to reason, plan or make decisions in their specialties. Typically, expert systems use informal reasoning procedures or rules of thumb. For example, an expert system may take the following as a given: If a Soviet ICBM is launched, it is a threat to the U.S. It may then use the converse of the statement as a legitimate rule of inference: If there is a threat to the U.S., it is a Soviet ICBM launch. The validity of this inference tool cannot be proved or disproved using the standard tools of formal logic; the statement is not true all the time but is sensible most of the time. The reliance on informal reasoning procedures in programming expert systems leaves open the possibility that deeply embedded conceptual contradictions in the system could exist that might cause it to fail.

To date expert-system research has focused on well-defined areas such as biochemistry and internal medicine. These are areas in which human expertise is sufficiently developed to allow expert systems some success. Even so,



SM-2 MISSILE is part of the U.S. Navy Aegis air-defense system. The Aegis battle-management system was designed to track hundreds of airborne objects and to carry out up to 20 simultaneous intercepts. During its first operational test it failed to shoot down six of 16 targets because of faulty software. The system's malfunctions have since been repaired. A comprehensive ballistic-missile defense, which is a much more complicated and ambitious weapon system, must perform far better than the Aegis system did, and it must do so in its first try; a severe software failure during the system's first full-scale test would offer virtually no opportunity to rectify the problem. Because large-scale testing is impossible, the first empirical test of the BMD system would be an actual large-scale ballistic-missile attack.

the technology is still limited. Those who recommend applying expert systems to battle management for ballistic-missile defense ignore the fact that human expertise is based on human experience. No one has expert knowledge of massive nuclear missile attacks based on experience.

Equally improbable is the idea that automatic programming, the use of computer programs to write other programs, will provide a solution. Air Force Major Simon Worden, special assistant to the director of the Strategic Defense Initiative Organization, has stated that "we're going to be developing new artificial intelligence (AI) systems to write the software. Of course, you have to debug any program. That would have to be AI too." Statements such as this one are misleading. The primary function of automatic programming is to alleviate the technical difficulties of implementing design specifications and modifying existing code. Roughly half of all software errors, however, are the result of human choices and decisions made during the planning and design phases. These human choices could not be delegated to automatic programming.

Two scenarios based on the above discussion show how the software for a comprehensive ballistic-missile defense might fail. Suppose a battle station that has successfully intercepted two missiles in operational testing using an electromagnetic railgun is faced with a large-scale Soviet missile attack. At first projectiles launched from the battle station destroy their targets. Unfortunately at the design stage developers neglected to take into account the fact that less massive objects have more recoil. As more projectiles are fired the recoil becomes stronger and skews the aiming algorithms for the railgun. As a result later projectiles are too slow and do not reach their targets in time to destroy them. Or suppose that, during the early phase of a nuclear war, U.S. and Soviet leaders agree to a cease-fire. The U.S. leaders realize that one submarine captain will not receive the cease-fire message in time but are confident that U.S. missile-defense satellites will be able to shoot down any missiles launched by mistake. Only after the submarine's missiles are launched does it become tragically clear that no developer had specified that the satellites might have to shoot down U.S. missiles. The missiles explode over the Soviet Union with catastrophic consequences.

Because they are anticipated, neither of these errors is likely to occur. The problem is not whether a system contains a particular error but rather how likely it is that the system will contain any one of millions of potential errors. The primary matter of concern is "unknown unknowns," the potential errors that remain unanticipated.

All the problems cited in this article are related to software planned, designed, implemented and debugged by experienced software engineers; most, if not all, were corrected. The general technique for correcting these errors, namely discovering the bugs in operational use and then correcting them, is unlikely to be fruitful in the development of a BMD system. Yet a comprehensive ballistic-missile defense requires not only that software operate properly the first time, in an unpredictable environment and without large-scale empirical testing, but also that planners are positive it will do so. The Reagan Administration has stated that empirical testing is essential for maintaining the reliability of nuclear weapons and has opposed a comprehensive test ban on these very grounds. One wonders how it is possible to have confidence in a comprehensive ballistic-missile defense, which will be at least as complicated as nuclear weapons are now, without requiring it to meet comparable test standards.

Proponents of the Strategic Defense Initiative argue that even in the absence of large-scale empirical testing a ballistic-missile defense is still desirable, because the possibility that the system might work reasonably well would deter Soviet leaders from contemplating an attack. Others argue that the goals of the Strategic Defense Initiative are really more modest than the goal of a comprehensive defense against ballistic missiles, suggesting that a BMD system might be most appropriate for protecting military assets such as missile silos. Of course, for goals more circumscribed than those of comprehensive ballistic-missile defense, perfection is not a requirement and testing is much easier. Although a program that has more limited goals does have a much higher probability of success, these limited goals raise a disturbing issue. In particular they are inconsistent with President Reagan's stated vision of eliminating the threat of nuclear ballistic missiles. Consequently it is proper to judge the feasibility of the Strategic Defense Initiative on the basis of the president's challenge to the scientific community. By that standard no software-engineering technology can be anticipated that will support the goal of a comprehensive ballistic-missile defense.

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The Star Wars Computer System

Greg Nelson and David Redell

25 June 1985

We make no warranty or representation, either express or implied, with respect to the software described in this manual, its quality, performance, merchantability, or fitness for any particular purpose. As a result, the software is sold 'as is,' and you the purchaser are assuming the entire risk as to its quality and performance. In no event will we be liable for direct, indirect, special, incidental, or consequential damages resulting from any defect in the software or manual, even if we have been advised of the possibility of such damages.

—Major software vendor's standard disclaimer

[In response to Senator Joseph Biden's question about the possibility that the President might make a mistake in a nuclear crisis]

We might have the technology so that he couldn't make a mistake.

Robert Cooper
Director of DARPA

Introduction

Computers play an endless variety of useful roles, and we rely on them to make life easier, more productive, and safer. Unfortunately, this makes us increasingly vulnerable to computer-related errors, which already cause aggravation, injury, and even death. As the state of the art of computing improves, and standards of professional discipline evolve, it should be possible to reap more and more benefits of the computer revolution without taking irresponsible risks. But the responsible balancing of risks and benefits is threatened by a general phenomenon in the world of computer systems: aspirations are rising faster than the technology that is expected to fulfill them.

Nowhere is this phenomenon more prevalent than in the design of computerized weapons systems, and no weapons system presents a more dramatic example than the computer system proposed for the Strategic Defense Initiative—the so-called "Star Wars" Anti-Ballistic Missile system. There are many serious difficulties with this computer system, falling into the following areas:

- System requirements: The ABM problem presents what may be the most difficult combination of mission requirements and hostile environment ever faced by a computer system.
- System complexity: The proposed system would be, in several ways, the most complex computer system ever built. Experience with previous large systems suggests that the project would be difficult and error-prone at best, and might well fail to achieve a deployable system at all.
- Testing difficulties: The nature of the ABM system prevents the kind of full-scale operational testing that is indispensable in the development of any large computer system. This difficulty is exacerbated by the fact that the ABM problem is inherently open-ended, involving as it does a cyclic contest of measure and countermeasure. This would lead to continual change and resulting instability in the software.
- Autonomous decision-making: The inherent time constraints in the ABM problem require a high degree of autonomy in the top-level decision-making software. This would introduce new levels of automation into the procedures for evaluating and responding to nuclear crises, and increase the danger that a flaw in the system could lead to an accidental nuclear war.

In the body of the paper we examine these problems from a technical perspective, focusing on the different ways in which the problems could cause the system to fail. We also briefly consider the uncertain strategic implications of the SDI effort.

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Strategic and technical context. Research on antiballistic missile systems began in this country in the late 1950s, leading eventually to the Safeguard system, which was deployed in the early 1970s but dismantled a few years later. The computational problems involved in tracking hundreds of objects were among the difficulties that were never satisfactorily resolved. In March, 1983, President Reagan gave ABM proponents a boost with his speech that envisioned a future in which nuclear weapons would be rendered "impotent and obsolete" because of advanced ABM systems. The speech led to the Strategic Defense Initiative, an ABM research program with an initial five-year, $26-billion budget.

The proposed Star Wars ABM system comprises a layered defense that would attempt to intercept enemy ballistic missiles during all phases of their flight, from boost phase through mid-course to reentry. A number of interception technologies have been proposed, including a variety of exotic beam weapons as well as kinetic energy devices, such as rockets and other projectiles. Similarly, a variety of sensors would be employed, including infrared and radar tracking devices. These technologies are described more fully in the references.[1, 6, 8, 15, 20, 21]

Some of the technical details of the Strategic Defense Initiative are contained in classified government documents, such as the full report of President Reagan's Defensive Technologies Study Team (the "Fletcher Report"). Most of the system's general design, however, is unclassified and has been published in the summary version of the Fletcher Report[20] as well as in books, newspapers and magazines.

The details of the computational system depend on the particular weapons employed, but the general requirements do not: prompt response is required to attack boosters; real-time requirements arise not only from servo controls for aiming sensors and weapons but also from the time constraints of the battle management schedule; a distributed system is required to provide redundancy and coordinate the different phases of the defense; and high computation rates and large volumes of data are required for the surveillance and tracking of tens or hundreds of thousands of objects in the mid-course and terminal-phase defense.

The computer system. The main source of information about the computational aspects of the Strategic Defense Initiative is Volume 5 of the Fletcher Report, "Battle management and data processing",[10] the only unclassified volume of the full report, and the only one to deal directly with data processing issues. The system description given there is very tentative, but the broad outlines are consistent with the obvious requirements that the computer system would have to satisfy.

The foundation of the proposed system is a ground-air-space packet-switching communications network, made reliable by replication of the communications links and computing nodes. Connected to the network are controllers for radars and optical sensors, controllers for directed energy weapons, activators for other intercept weapons, high-speed processors, data storage devices, and terminals for human operators. As its name implies, the network is intended to comprise components distributed on the earth, in airplanes, and in satellites.

Probably the most computation-intensive task required is "track formation". Phased array radars are capable of emitting many thousands of individually-aimed pulses per second; under appropriate computer control, these could be used to resolve a threat cloud into a set of tracks of individual objects. Optical or infrared sensors, whose shorter wavelengths offer the potential for sharper angular resolution, also require high-bandwidth controllers. Because the computing requirements are so high, both in absolute terms and in asymptotic growth rate, these algorithms may become saturated by large numbers of decoys. The Fletcher Report estimates that the computing nodes controlling radars and optical sensors must perform between ten million and one billion floating-point operations per second.[10a] The report also calls for research into realistic algorithms for track formation.[10b]

As individual objects' tracks are identified, they are stored in a global database that is accessible by boost-phase, mid-course, and terminal-phase battle management software. For reliability, several replicas of the database are maintained, since many node and link failures can be expected during an attack, due both to disruption by radiation and other effects, and to outright destruction of numerous components of the system.

The battle management software includes a scheduler that allocates defensive resources (e.g., sensors and weapons) to targets. This allocation must be coordinated across the various elements of the system, and must be resilient in the face of damage to the network, the computers, and the resources themselves. Moreover, the resource allocation must occur in the context of a coherent battle plan that takes into account the nature of the attack and a host of other variable parameters. The Fletcher Report is quite explicit about the central role of the computer system: "The battle management system will, through its software, define and control the functioning of the entire defense and, thereby, define its effectiveness and establish performance requirements for weapons and sensors."[10c]

The programs for the system and the orders for the human operators would have to ensure that the appropriate battle plan be activated within seconds of a warning, since the crucial boost phase, during which missiles are vulnerable to attack, is so brief. Because of these time constraints, several battle plans would be programmed in advance, so that in the event of a crisis that threatened to lead to an attack, human operators would simply select one or more battle plans and specify their important parameters, leaving their activation and execution to the computer system. Thus, the highest level of the battle management software would exercise a decision-making function of the utmost importance, constituting the most important decision ever delegated to a computer program.

Technical Risks

There are several ways in which the SDI software project might fail: (1) The attempt to build and deploy the system might fail outright, because of its complexity. (2) The system might be successfully deployed, but fail under attack. (3) The system might be successfully deployed, and then activate itself under unanticipated circumstances.

Outright failure to develop and deploy the system. Assuming that computation rates and radiation hardness continue to improve at current rates, the individual hardware components of the SDI computer system are likely to become feasible in the next decade or so. On the other hand, the problems of designing the entire system, writing the software, and integrating the various components are much less likely to be satisfactorily resolved. Programming large software systems is more an art than a science, and progress in this art has been disappointingly slow.

One potential source of software complexity lies with the processors themselves. In principle, the complexity of high-performance fault-tolerant processors should be confined to the lowest levels of the system. In practice, fault-tolerant systems have been harder to program than conventional ones. In this way, the very measures designed to guard against failures in the hardware can induce a new class of failures in the software. For example, one of the first flights of the space shuttle was stopped at the last moment by a software error that caused a synchronization problem between the shuttle's redundant processors.

The major source of complexity in the SDI system, however, would be in the construction of the complete distributed software system, combining as it does fault tolerance, networking, distributed databases, real-time control and signal processing, resource allocation, artificial intelligence, and complex human interface issues.

There is little doubt that it is possible to build the lowest level of the proposed ground-air-space network, allowing simple data flow from point to point in the network. It is much harder to design and implement protocols that maintain communication in the face of failures in individual nodes and communications links, particularly when the failure rate is high, as it would be during a nuclear war. Even more complexity stems from the requirement that separate nodes share access to a replicated database and maintain the database in a consistent fashion. Moreover, the requirement that the system satisfy stringent real-time constraints introduces additional problems and complicates existing ones.

These difficulties represent challenging research problems even when restricted to a local area network with homogeneous nodes clustered within a few kilometers of one another. The SDI system requires solutions for a heterogeneous network spanning thousands of kilometers. The Fletcher Report issues a "word of caution" because the diameter of the network in light-milliseconds would be large enough that speed-of-light limitations would create inherent latency delays in synchronizing shared data that were large compared with the reciprocal bandwidth of the servo control systems.[10d] In practice, this would be only the tip of a larger iceberg, since much longer delays would be introduced by the network's packet-switching system and the processing in the higher levels of the software.

In addition to the design problems outlined above, the builders of a distributed system meeting the Fletcher Report's specifications would face a number of difficult logistical problems in the deployment, operation, and maintenance of such a large and complex software system. Work on a large computer system does not end with initial installation, but continues over the entire useful life of the software. This would be particularly true of the SDI system, in which software changes would be needed not only to fix problems, but to enhance the system in the face of new threats and countermeasures by an adversary. The distribution of software updates, a difficult problem in any case, is rendered more difficult when the target computers are part of a network of orbiting satellites. The typical current practice for space-based computers is to send a small machine language patch to repair each flaw. Obviously, this error-prone practice would be totally inadequate for such a large system on which so much would depend. The Fletcher Report acknowledges that a "problem with space-based assets is the difficulty of upgrading the software and then verifying that the system is operating correctly",[10e] but makes no attempt to address this difficulty.

A useful sense of perspective is provided by comparing the SDI plans with past and present computer systems. Two systems that are particularly relevant are the Safeguard ABM computer system and the World-Wide Military Command and Control System (WWMCCS — pronounced "Wimmix").

The Safeguard system controlled the radars, missiles, and human command interface for one re-entry phase ABM installation. It contained about two million lines of software running on ten 1.5 MIPS processors.[3] The real-time portion of the system contained three-quarters of a million instructions. It was characterized in the Bell System Technical Journal as one of the most complicated real-time systems ever built, although it was much smaller and simpler than the proposed SDI system.

WWMCCS is the Pentagon's world wide communication system, built at a cost of between ten and fifteen billion dollars and involving more than ten million lines of software. It is thus about the same size as the proposed SDI system, but is much less tightly integrated and does not encounter the kinds of real-time constraints that are inherent in the ABM problem. The system has not been reliable: according to Atlantic Monthly editor James Fallows, "Once or twice a month, the newspapers carry a story about the WWMCCS computers breaking down. When the system was thoroughly tested in 1977, attempts to send messages ended in 'abnormal terminations' — that is, breakdowns — 62 percent of the time".[9] Major General D. L. Evans, head of the WWMCCS effort, concedes that studies by Congress and the General Accounting Office "were very critical of the current WWMCCS ADP systems. By and large, the criticism was well founded".[11a]

These two comparisons suggest that the Fletcher Report is not unrealistic in estimating the size of the software for the SDI system at six to ten million lines.[10f] They also suggest pessimism about the prospects for successfully deploying the system. Empirical studies of large software systems have led to models of cost and error density as a function of program size; Lin[16] applies these models to the proposed SDI computer system and concludes that it would take tens of thousands of man-years to design and implement, and would be impossible to deliver free from errors.

There is a common tendency to expect rapid progress in software technology, simply because there are no physical constraints that need to be overcome. "All" that is required is mental mastery of complexity. Such optimism is misplaced, and is one of the major causes of aspirations overreaching capabilities in computer projects. There are many areas in software engineering where the state of the art is depressingly similar to the state twenty years ago. Despite gradual improvement in our understanding of large software systems, it is likely that any SDI computer system deployed within the next two decades would display the same kinds of shortcomings that are rampant in most large software systems deployed today.

In summary, it is possible that the attempt to build the computer system for the SDI would fail outright. It strains the state of the art in so many areas that it could easily get out of control, as so many large software projects do. But it is equally possible that a stubborn attempt would lead to the deployment of an unreliable system. In this context it is worth quoting C. A. R. Hoare's 1980 Turing Award Lecture, in which he remarked of another large software project:

> At first I hoped that such a technically unsound project would collapse, but I soon realized it was doomed to success. Almost anything in software can be implemented, sold, and even used given enough determination. There is nothing a mere scientist can say that will stand against the flood of a hundred million dollars. But there is one thing that cannot be purchased in this way — and that is reliability.[14]

The possibility of failure under attack. The main reason for this second concern is the impossibility of testing the system under full-scale operational conditions. It is the universal experience of computer system designers that reliability cannot be achieved without such testing. Since we have no spare planets on which to fight trial nuclear wars, operational testing of a global ABM system is impossible. The system would have to work the first time. No computer system even a fraction of the size of the SDI system has ever worked perfectly in its first operational use.

The Fletcher Report acknowledges that "there will be no way, short of conducting a war, to test fully a deployed BMD system", and that therefore "the credibility of a deployed system must be established by credible testing of subsystems and partial functions".[10g] Experience shows, however, that this technique is a totally inadequate substitute for testing under operational conditions. The first real use of any large computer system inevitably uncovers flaws that did not show up previously in simulations and partial tests. Some early examples are cited by McCracken:[17] after extensive in-house testing, the first release of IBM's OS/360 revealed five thousand errors. Similarly, the SABRE airline reservation system was carefully tested in small cities before its first large release in New York. The system worked well in the small tests, but in the high-volume situation it sold two hundred seats on 90-seat airplanes all over the country. All subsequent experience has shown such results to be typical: real operational use invariably reveals scaling, saturation, and other problems that would never have been discovered by limited testing or simulation.

Any large system that has been exercised only in partial tests and simulations will lack credibility, but in addition, there are special problems with an ABM system that make simulation-testing particularly difficult. There are no complete specifications for the problem being solved by the battle management system, because we cannot know exactly what countermeasures the Soviets would use to fool, disable, destroy, overload, and penetrate the defense system. There is no way to simulation-test the system against such unanticipated attacks. Related to this problem is the fact that the system would be subject to frequent updates. Its battle management software would encode detailed plans for dealing with particular Soviet threats: as these threats changed, so would the software. The Fletcher Report cautions that "when a system is upgraded with new capabilities, the probability of introducing new errors is very high".[10h] The ability of a massive ongoing simulation project to establish and maintain the credibility of such a large and continuously evolving body of software is questionable, to say the least. A third difficulty is that simulation testing of an ABM system must be carried out effectively in real time if it is to reveal timing errors. Therefore, simulated stimulus data that are computed in advance must be delivered during the test in simulated real time. Unfortunately, if the system interacts with its environment during the test in ways that affect its input stream, this technique won't work. In short, credible simulation testing of any real-time closed-loop system is extremely difficult, and for a system as large as that envisioned for the SDI, may simply be impossible.

The Apollo project is sometimes cited as an example of a similar system where simulation testing succeeded in producing reliable operation on its first use. In addition to ignoring the special problems cited above, however, this argument is based on a questionable representation of the Apollo software development: many errors in the NASA control programs were weeded out by operational testing in the Mercury and Gemini projects. For example, Gemini 5 came down 100 miles from its intended reentry point, because a programmer had neglected to account for the orbital motion of the earth around the sun.[12] Thus software errors that might have been disastrous in the Apollo missions were discovered by earlier operational testing. Even so, during the first moon landing, the computer in the Apollo 11 Lunar Module failed due to software problems; only emergency manual intervention by the pilot saved the mission from a last minute abort.

It is sometimes argued that operational testing will be made unnecessary by the development of automatic program verifiers that certify the correctness of formal mathematical proofs of the consistency of programs with their specifications. Unfortunately, progress in automatic verification has been slow, and the prospect of proving the consistency of a ten million line program with its functional specification is extremely remote. A more fundamental weakness of the argument is that many kinds of flaws in large systems represent errors in specifications rather than inconsistencies between programs and specifications; for example, error-prone features in user interfaces, or the neglect of relevant physical phenomena (*e.g.*, the orbital motion of the earth around the sun). Because of the complexity of the requirements for the SDI computer system, which are influenced by targeting doctrines, battle management plans, constraints of user interfaces, and the physical environment of weapons and sensors in space, any formal specification derived from the requirements would contain flaws that could be revealed only by operational testing.

The message of responsible proponents of program verification and similar disciplines of programming is not that mechanical verification can replace operational testing of large systems, but that a disciplined design employing formal specifications and a *priori* correctness arguments is necessary in addition to operational testing. In the case of the SDI computer system, the state of the art is limited to informal specifications and at best partially convincing correctness arguments for the major components of the system, such as replicated data bases, failure-resilient communications protocols, and fault-tolerant high-performance architectures. In short, the required computer system is too complicated to be designed by the disciplined methodology advocated by programming formalists. Thus, if it somehow did become possible to perform repeated operational tests of the ABM system, we can predict the outcome: the system would exhibit unanticipated failures that might or might not be amenable to later repair.

An illustrative example of the unreliability arising from even moderate complexity occurred when the DIVAD (Division Air Defense) computer-controlled cannon was demonstrated to a military review panel. The drone target flew by, the gun swung into action, passed right by the drone, swung all the way around, and pointed itself straight at the review stand, whose occupants scattered for cover. This suggests that the DIVAD test team had not done an adequate job, since thorough testing should have revealed the error under less embarrassing circumstances. There is another possibility: perhaps the testing team did a thorough job, but the design was so complex that the bug revealed in the demonstration was too obscure for the tests the kind of bug that strikes only when the forward radar is wet, the target is flying north, and the date is February 29. In this case, the blame would lie with the weapon's designers, who failed to master the complexity of their design.

In passing we call attention to a nontechnical but very serious problem: the Department of Defense (like many other institutions) rarely tests its systems as thoroughly as it plans to. A discussion of this problem and a list of references is contained in a 1983 General Accounting Office report to Congress on DoD testing.[7] The report makes it clear that weapons systems that prove difficult or impossible to test adequately are often deployed anyway, with the predictable result: chronic unreliability.

In summary, it is folly to rely on any computer system that has not been subjected to full-scale operational testing; if the system is as large and complicated as the proposed ABM system, the folly is monumental: all experience teaches us that flaws would surface in the first operational use of the system in a real nuclear war.

The possibility of unanticipated activation. It is an old aphorism of radar engineers that probability of detection is meaningless without probability of false alarm. Similarly, there is an inherent tradeoff between ensuring that the SDI computer system will respond to a missile attack and ensuring that it will not activate itself in unanticipated circumstances.

The existing early warning system depends heavily on human judgment to identify false alarms and pull in the reins of the systems and procedures that would otherwise unleash our strategic nuclear arsenal. According to a Senate report on false alerts,[13a] thousands of "missile display conferences" were held during the years 1979 and 1980 to evaluate ambiguous data picked up by warning sensors or false alarms caused by faulty hardware, unanticipated natural events, or human error. If a missile display conference cannot discount a warning, the next step is to convene a threat assessment conference, which "brings more senior people into the evaluation, such as the Chairman of the Joint Chiefs of Staff".[13b] Four threat assessment conferences were held in 1979 and 1980, for the following reasons:[13c] On October 3, 1979, the radar reflection of a rocket body in low orbit generated a false alarm. On November 9, 1979, a technician accidentally directed missile attack simulation data from a test tape into the early warning system. On March 15, 1980, a Soviet SLBM test launch was misclassified as threatening. On June 3, 1980, and again on June 6, a faulty chip in a communications multiplexor began setting bits randomly in the message data field containing the count of the incoming missiles detected by early warning radars. Note that we can infer from this accident that the elementary precaution of parity checking was omitted from the communication protocol. This revelation should have provoked an outcry; its quiet reception is evidence of a lack of mature discipline in the computing profession.) In short, the complexity of the early warning system and its constantly changing environment produce a stream of false alarms, most of them minor.

A similar stream of false alarms can be expected from the SDI computer system, since it too would be complicated and deployed in an unpredicatable environment. But the time limit for identifying a false alarm would be drastically reduced, because the boost phase currently lasts less than five minutes, and fast burn boosters could reduce it to less than one minute. Technicians cannot be expected to identify, in so short a time, the causes of anomalies in the behavior of a ten million line program running on a system distributed in space and over much of the earth. Threat assessment requires the evaluation of the ambiguous, the uncertain, and the unexpected, and therefore is unsuited for automation. Automatic systems are reliable only in circumstances that have been forseen by their designers; this fundamental fact holds for expert systems as well as for other systems.

Unfortunately, the SDI plans involve increasing the level of automation in threat assessment, both by delegating to automatic systems functions previously performed by humans, and by streamlining the functions that are left to humans. Weapons release will also be automated, although whether this automation will be confined to defensive weapons release or extend to offensive nuclear weapons is not addressed explicitly by the Fletcher Report. The Report does conclude that "the battle management system must provide for a high degree of automation to support the accomplishment of the weapons release function".[10] The 1985 report to Congress on the SDI states that studies are being made "on the speed and accuracy with which human test subjects can assess situations and make decisions. Performance is being compared as a function of the format and content of the data displayed, in situations that realistically represent possible battle scenarios".[23] The Fletcher Report states that the SDI system would be programmed so that human operators could "define thresholds or contingencies within which release of weapons is delegated to the automated system. Examples are release nuclear weapons for defense of own resources, release hit-to-kill weapons if more than ten boosters are in track, and release all nuclear weapons if more than 100 boosters are in track".[10]

The dangers of automating threat assessment and weapons release are increased by the feedback between our C^3I system and its Soviet counterpart. Paul Bracken writes in *Command and Control of Nuclear Forces*:

> A threatening Soviet military action or alert can be detected almost immediately by American warning and intelligence systems and conveyed to force commanders. The detected action may not have a clear meaning, but because of its possible consequences protective measures must be taken against it. The action-reaction process does not necessarily stop after only two moves, however. . . . The possibility exists that each side's warning and intelligence systems could interact with the other's in unusual or complicated ways that are unanticipated, to produce a mutually reinforcing alert. Unfortunately, this last possibility is not a totally new phenomenon; it is precisely what happened in Europe in 1914. What is new is the technology, and the speed with which it could happen.[2]

It is important to remember that the SDI battle management system would be incorporated into the overall C^3I system, which also drives the decision process for release and launch of nuclear missiles. Already, in fact, "the Joint Chiefs of Staff have begun discussions of . . . a nuclear war plan and command structure that would integrate offensive nuclear forces with the projected anti-missile shield".[18] Thus, the highly automated SDI threat assessment and weapons release functions would become factors in the feedback cycle described by Bracken. The automatic release of the ABM weapons in response to a perceived Soviet threat would in turn be perceived by the Soviets as a provocation.

Such feedback effects could occur between the battle management software of opposing ABM systems, if both sides deployed them. The short reaction times and resulting absence of human damping could lead the systems to initiate preemptive attacks on each other. This fear is consistent with experience with other complex systems, which can fail in surprising ways because of unanticipated ripple effects. Power grid failures and other examples show that complicated automated systems can exhibit global behavior that was neither intended nor anticipated by their designers.

Detailed scenarios for the outbreak of nuclear war are inherently speculative, but the danger from increased automation is clear. An accidental war is not likely to be caused because an isolated hardware or software failure activates a weapon on an otherwise normal day. The danger is that the warning and response system as a whole—hardware, software, and standing orders that direct human beings to play their individual roles—is sufficiently complicated that its behavior in a crisis is unpredictable. It will interact in unexpected ways with itself and with its Soviet counterpart. In a crisis, the safety catches on the triggers would be removed, and procedures would be activated that had only been simulation-tested before. Flaws in the system would surface, possibly with disastrous consequences. This danger exists today, but it would grow in proportion to the level of automation in the process of threat assessment and weapons release.

Strategic Implications

When a large project is launched with unrealistic aspirations, the usual result is for the original goals to be quietly abandoned as the project is channeled in unforseen directions by insurmountable technical barriers. The final result can be dramatically different from the original vision. For example, Dijkstra has pointed out that the original goal of the COBOL project was to make the professional programmer superfluous, but its result was to provide the language now used by three out of four professional programmers.

The SDI has already shown this kind of metamorphosis, as its original goal of freeing us from the need for deterrence is replaced by the goal of "enhancing deterrence". President Reagan underscored his original goal by suggesting that we would eventually share our ABM technology with the Soviet Union, as a prelude to disarmament. One of many objections to this suggestion is that it is not feasible for the computer software, both because the Soviet Union would have no protection against "trojan horses" in the programs, and because the constantly evolving battle management software would contain extensive details of our assessment of Soviet strategic plans and our intended responses to them, as well as potential loopholes in our defenses that could be discovered and exploited.

The technical uncertainty about the outcome of the SDI is compounded by the strategic uncertainty created by the dynamic and adversarial relationship between offensive and defensive weapons systems. As General Herres, head of C^3I for the Joint Chiefs of Staff puts it: "Every time you think you've got one threat whipped, then somebody thinks up another one. It's a never-ending cycle. I rail at the guys who think one of these days ... everything will be all right. It'll never be all right".[11b] It is difficult to predict the effects of weapons projects on this never-ending cycle, even if they are technically straightforward. For example, the original justification for MIRVs was to provide insurance against the possibility of Soviet ABM systems. The ABM treaty removed this justification, but the MIRVs remained. Today they are widely regarded as destabilizing, because one MIRVed missile can threaten many of an opponent's missiles, and therefore they make a first strike more tempting.

The SDI could backfire in the same way. The current rationale is that the ABM system would enhance deterrence, since its tendency to blunt a first strike would make reprisal more certain. Unfortunately, for technical reasons it is more likely to undermine deterrence, since its tendency to blunt a reprisal could make a first strike more attractive. During a period of international crisis, each side's hesitancy to launch its missiles would be gradually eroded by its mounting fear that the other side might attack first. In this scenario, the important consideration is the disadvantage of a second strike relative to a first strike. Any change that increases the relative advantage of striking first will tend to make the crisis unstable. The deployment of an imperfect ABM system would be just such a change, since the leakage of the system would be due, in large part, to saturation and overload of the computer system and other resources. Even with increases in computation speeds, tasks with computational time or space requirements that are more than proportional to the problem size, such as the task of tracking a cloud of objects, could easily become vulnerable to saturation. Because of saturation, the leakage of the system is likely to be much greater during a massive first strike than during a weakened second strike.

In short, it is impossible to predict the final outcome of so ambitious a project as the SDI, because of both technical and strategic uncertainties. Its goals will continue to be redefined as technical barriers are encountered and strategic theory changes. The gamble that something good will come out of it should be weighed against the forseeable dangers, discussed in the references,[4, 5, 10] which include the possibility of Soviet countermeasures and the loss of the ABM treaty. This treaty prohibits not only the deployment, but also the development and testing of ABM systems; therefore proceeding with the SDI effort would violate the treaty long before we could know what the final outcome of the effort would be.

Conclusions

The computer system required by the Strategic Defense Initiative is the most complicated integrated computer system ever proposed. We have surveyed some of the difficulties in building such a system. The problems of software and system integration are far more serious than the problem of achieving the required radiation hardness and high computation rates. Flaws in any system of its size are inevitable. An attempt to build the system would not necessarily succeed, and if it did succeed, uncertainties would remain about its reliability. It is impossible to test the system under operational conditions, yet component testing and system simulation are totally inadequate substitutes. It would be folly to rely on such a system in the absence of full-scale operational testing.

Because of the time constraints for attacking boosters, the proposed system is required to activate itself within seconds of a warning. This would require increasing the level of automation in threat assessment and weapons release. But automatic systems are unsuited for coping with the ambiguity, uncertainty, and unexpected events that are likely in a military crisis. Increasing the degree of automation in the handling of crises would increase the risk of nuclear war.

As the state of the art improves, it becomes possible to build reliable systems that are larger and larger. An optimist might expect that, except for the fundamental impossibility of operationally testing the system, the difficulties outlined in this paper might be solved in a couple of decades. But if history is any guide, what we will have in a couple of decades is an unreliable and destabilizing ABM system along the lines of the one described in the Fletcher Report, together with a grandiose plan to build another even bigger system, intended to solve all the old problems and new ones besides.

The fundamental attitude at work here is what Bundy *et al.*[4] refer to as "technological hubris" a chronic tendency to overestimate our technical capabilities and underestimate the difficulty of the problems we undertake to solve. The result of this attitude is the recurring phenomenon of extravagant aspirations that lead so many large computer projects to failure. The general responsibility of the computing profession to restrain the unrealistic aspirations of its clients becomes a vital obligation in the case of projects, like the Star Wars system, that introduce automation into the procedures that would determine the outcome of a nuclear crisis.

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[Questions submitted for the hearing record with answers supplied follow:]

QUESTIONS SUBMITTED BY SENATOR JOHN WARNER

TECHNICAL PROBLEMS FACING THE SDI PROGRAM

Senator **WARNER**. Dr. Buchsbaum, with your background and expertise, do you see any technical problems facing the SDI program that are insurmountable?

Dr. **BUCHSBAUM**. I don't see any technical problems that would preclude an effective strategic defensive system from being built. There are still very many problems which the SDI program faces to which there are not yet solutions. That's why vigorous research is necessary. But, I would not call any of these problems "insurmountable".

EASTPORT GROUP CONCLUSIONS ABOUT SDI

Senator **WARNER**. Dr. Cohen: Has the Eastport Group reached any preliminary conclusions about SDI computer and battle management issues, and if so, could you please summarize these for us?

Mr. **COHEN**. The Eastport panel has reached several conclusions. I will summarize them by quoting from the upcoming report of the panel:

"The panel concludes that computing resources and battle management software for a strategic defense system are within the capabilities of the hardware and software technologies that could be developed within the next several years. However, the anticipated complexity of the battle management software and our ability to test, simulate, modify, and evolve the system make battle management and command, control, and communication the paramount strategic defense problem.

"Software technology is developing against inflexible limits in the complexity and reliability that can be achieved. The tradeoffs necessary to make the software task tractable are in the system architecture. As indicated in the Fletcher Report, the 'applique approach' of designing the system first and then writing the software to control it is the wrong approach for SDI.

"One promising class of system architectures for a strategic defense system are those that are less dependent on tight coordination than is implied by the Fletcher Report. The advantages of this type of architecture include robustness, simplicity, and the ability to infer the performance of full-scale deployment by evaluating the performance of small parts of the system. Otherwise, the United States could not test a full-scale deployment short of actual use. The panel prefers an unconventional architecture that simplifies the software development and testing tasks over reliance on radical software development approaches and the risk that reliable software could not be developed by the 'applique approach' at any cost."

In addition to the above conclusions, the panel made several other recommendations to SDIO regarding various issues such as hardware, software, simulation/testing, and communication. The most important recommendation is probably that the software for the strategic defense system will follow the communication paradigm, as decribed earlier both by Mr. Buchsbaum and myself.

Senator **WARNER**. I thank each of you. This has been one of the more valuable sessions in our series of hearings.

Thank you.

Mr. **COHEN**. Thank you.

[Whereupon, at 5:15 p.m., the subcommittee adjourned, subject to the call of the Chair.]

STRATEGIC DEFENSE INITIATIVE

THURSDAY, DECEMBER 5, 1985

U.S. Senate,
Subcommittee on Strategic and
Theater Nuclear Forces,
Committee on Armed Services,
Washington, DC.

ALLIED PARTICIPATION

The subcommittee met, in open session pursuant to notice, at 2:10 p.m., in room SR-222, Russell Senate Office Building, Senator John W. Warner (chairman) presiding.

Present: Senators Warner, Thurmond, Quayle, Nunn, Exon, and Levin.

Staff present: Arnold L. Punaro, staff director for the minority; Alan L. Chvotkin, counsel; Robert G. Bell, Robert F. Bott, Douglas R. Graham, Drew A. Harker, and William E. Hoehn, Jr., professional staff members; Judith H. Freedman and Russell C. Miller, research assistants; Karen A. Love, staff assistant.

Also present: Romie L. Bownlee, assistant to Senator Warner; James M. Bodner, assistant to Senator Cohen; Henry D. Sokolski, assistant to Senator Quayle; Mark J. Albrecht, assistant to Senator Wilson; John B. Keeley, assistant to Senator Levin; and Gregory B. Craig, assistant to Senator Kennedy.

OPENING STATEMENT BY SENATOR JOHN W. WARNER, CHAIRMAN

Senator Warner. The subcommittee convenes in open session this afternoon to continue with our series of hearings on the President's Strategic Defense Initiative.

In previous hearings we have focused on some of the technical and policy objectives of the SDI Program. Today we will focus on the important issue of allied participation in SDI research activities.

Our witnesses this afternoon are Mr. Richard Perle, the Assistant Secretary of Defense for International Security Policy, and Lt. Gen. James Abrahamson, the Director of the SDI Organization. On behalf of the subcommittee, I would like to welcome both of you this afternoon.

In my view, it is very important that we consult with our allies as closely as possible while we pursue the SDI Program, and that they be encouraged to participate actively in the program. This is not simply because U.S. national security and that of our allies is inextricably linked, but also because our allies possess strong technical capabilities in a number of areas that will assist us in meeting the objectives of the SDI Program.

In this regard, I would like to commend our witnesses who have spent much of their time in recent months traveling among allied capitals. I attach a great deal of importance to these consultations.

I would also like to commend my colleague, Senator Quayle, for his interest in this subject. At his request, the subcommittee may conduct a hearing during the week of December 16 in which we will focus on the requirement for an antitactical ballistic missile system in greater detail.

Mr. Secretary, we will lead off with you.

STATEMENT OF HON. RICHARD PERLE, ASSISTANT SECRETARY OF DEFENSE FOR INTERNATIONAL SECURITY POLICY

Mr. **Perle**. Thank you very much, Mr. Chairman.

I would like to take this opportunity to review the administration's policy regarding allied involvement in SDI research and a description of where we stand today in our discussions with our allies.

I should also like to touch on the issues associated with allied participation in which the committee may be especially interested.

I will be happy, of course, to answer any questions.

As you will recall, Secretary Weinberger on behalf of the President extended an invitation last March at a meeting of the Nuclear Planning Group to our NATO allies and some others to join with the United States in the SDI Research Program to determine whether there are any defense technologies that could enhance deterrence and increase stability.

Our NATO allies together with Japan, Australia, Israel, and Korea, were invited to participate in the program. The invitation was prompted by our conviction that U.S. security is inextricably linked with that of our allies and hence our allies ought to have an opportunity to join with us in participating in the Research Program intended to enhance their security as well as our own.

Moreover, in informal discussions with our allies, a number of them expressed the hope that the SDI Program might be open to their participation. To provide interested allies with a thorough technical understanding of the SDI Program and to assist General Abrahamson's organization, a number of government institutions, industries, and universities have been exposed to technical briefings in Washington and have made tours of various U.S. SDI research facilities and laboratories.

General Abrahamson has traveled to many countries for this purpose and many allied experts have visited the United States. We have indicated to our allies that we were prepared to respond to any form of interest that they might choose and in that regard made it clear we welcome both direct government participation in the program as well as the involvement of private firms, institutions, universities, and the like.

If a government chooses not to participate directly in the SDI Program, we respect that decision. Several allied governments have indicated they will not participate directly, but that their private industries and institutions are free to do so.

The Canadians, French, Danes, Dutch, and Norwegians have taken this position. That is, the governments will not participate directly, but their firms are permitted and in some cases encouraged to do so.

The Australian and Greek Governments have indicated they would rather not participate, but have made no statement regarding the private participation of industries in their countries.

For our part we have often stated that a direct government role other than that required by necessary security arrangements is not necessary for allied firms that may seek to participate in SDI research contracts.

As a practical matter, however, new government-to-government agreements would facilitate broader allied participation than would otherwise be possible. It is not a requirement that there be government-to-government agreement, but we think of those cases where there are, the prospects of participation are significantly increased.

The Defense Department has been engaged in bilateral negotiations with the Ministry of Defense of the United Kingdom concerning British participation in the program. Secretary Weinberger and Defense Minister Michael Heseltine recently reached an essential agreement on a memorandum of understanding that will enter into force when it has been approved by Her Majesty's government. The Secretary is in London at the moment.

While the basic understanding has been arrived at, the British Government may wish further to consider when and how they will proceed. So, while we think it likely there will be a government-to-government overarching agreement between the governments, I cannot tell you when that will be concluded.

With respect to participation by the Federal Republic of Germany, we expect the government in Bonn to make a decision in the fairly near future on whether and how they wish to participate in the program.

We expect a similar decision in the not too distant future from the Italian Government.

Perhaps I should say a word or two about the sorts of policy issues that have been associated with the question of allied involvement.

The first deals with the ABM Treaty constraints and how they bear on allied cooperative research. The United States, as you know, is conducting the SDI Program in full compliance with the 1972 treaty.

Let me assure the subcommittee that cooperative SDI research efforts undertaken with allied governments, institutions, industries, and universities will be subjected to continuing review to assure compliance with U.S. international obligations, including the ABM Treaty.

We have developed a set of guidelines and procedures to assure that all exchange of data with allied cooperative research efforts are in compliance with our obligations under the treaty.

With regard to the longstanding U.S. concern about technology transfer to the Soviet Union, I want to emphasize that the illegal and improper flow of technology remains a major concern of this administration, not only with respect potentially to SDI research, but also for other types of cooperation in the defense area, indeed, in areas of high technology and that have both defense and nondefense purposes.

The provisions of SDI research contracts in any bilateral arrangement regarding allied cooperative research will reflect the commitment of the administration to prevent unauthorized dissemination of sensitive SDI information bearing on our security.

In terms of security arrangements to protect classified SDI research, there are a number of requirements which must be satisfied in order for a foreign contractor to perform or receive information necessary to bid on SDI contracts with subcontractors.

Under the terms of the U.S. national disclosure policy and/or bilateral information and industrial security agreements, the potential foreign contractor must be cleared by its own government. Classified information involved in the contract must be approved for release by the United States to the receiving government, and that information must be transferred through government-to-government channels utilizing the security systems and procedures that they have and that are subject, in the case of NATO, to a NATO-wide standard.

We intend to adhere to the strictest safeguards in order to protect sensitive SDI Program information and technology.

Mr. Chairman, that summarizes our approach to allied cooperation. I would only add that I have had an opportunity to meet with many officials from allied governments who have come to this country and those who have had an opportunity in connection with their own deliberations to visit our facilities, to go out to the laboratories to meet with General Abrahamson's program people. They have come away from those discussions and those visits with the kind of enthusiasm that the people involved in the program communicate because they feel it themselves so deeply.

I think as time has gone on, some of the initial skepticism that we experienced has dissipated, not entirely, but to a significant degree. I think that is a tribute to the sense of optimism and progress that the people involved in the program have conveyed to those officials who have had a chance to see them at work.

Senator **Warner**. Thank you, Mr. Secretary.

We will now hear from General Abrahamson and then have questions.

STATEMENT OF LT. GEN. JAMES A. ABRAHAMSON, DIRECTOR, STRATEGIC DEFENSE INITIATIVE ORGANIZATION

General **Abrahamson**. Mr. Chairman, I am delighted to be back. I think this is a critical and timely subject, given the extensive discussions we have had with many of our allies and where we are in that particular process.

Rather than read my entire statement, I would like to start in the middle of page 7. I would like to point out for the subcommittee that the initial several pages deal with the rationale and the importance of our deterrent, whether it be offensive or defensive, to our allies protection, and the very close relationship of our security to theirs. Therefore, I recommend that portion of the statement.

However, I will turn to the more practical steps that we have engaged in, starting with the second paragraph on page 7.

Turning to the steps taken by Secretary Weinberger inviting allies to participate in the program, we saw considerable scientific and technical expertise amongst our allies in their scientific and industrial communities. Certain allied contributions could reduce both the schedule and the cost of the SDI Research Program.

Beyond the important technical contributions which allied participation may make, we believe that their involvement will certainly lead to a more indepth understanding of the program and the technical basis for defense as well as its military basis.

This understanding will be a vital underpinning of a future decision to proceed into development. We have pledged to make that future decision to proceed into development. We have pledged to make that future decision in full consultation with our allies as well as to attempt negotiations with the Soviets.

Moreover, allied participation will spark a latent synergism, not only in defense against ballistic missiles, but also in the conventional arms arena.

There are many unique and important technical capabilities that our allies can bring to the SDI research efforts—in some cases, it may be a meaningful technology base in certain areas; for example, the SDI directed energy research program.

In this area, several of our allies have ongoing, advanced programs involving small, but very specific laser and particle beam research which could complement efforts underway in the United States.

In the field of optics, specialized high quality materials and advanced construction techniques are areas of research expertise found in several allied nations. There are also allies who have extensive programs involving gallium arsenide research, computer research, composite materials, electromagnetic launchers, and infrared sensors as well.

While the attraction of a different array of scientific talent is a powerful factor for our interest, there are also others, such as access to special facilities or teams of researchers with unique experience, or that have brought special technology partway and taking it further may be useful for the SDI.

In the climate of limited resources, every effort must be made to derive maximum benefit from our defense dollar. If certain jobs can be done more effectively, at less cost, or more quickly, in the hands of our allies, then it is incumbent on us as responsible managers to seriously consider such execution.

To derive the greatest benefit from allies expertise throughout the various SDI research areas and satisfy the need to keep them as fully informed as possible of the desirability of defense-oriented forces, the United States should proceed toward developing a meaningful allied role in SDI research, and I would like to underscore this, as Secretary Perle indicated, one consistent with our technical requirements, laws, regulations, and international obligations.

As the SDI Program is moving ahead at a very rapid pace, our near-term goal is to give our allies early opportunities to participate in SDI research. We initiated this process with the Secretary's invitation. It was sent to 18 of our allies—Australia, Belgium, Canada, Denmark, the Federal Republic of Germany, France, Greece, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, and the United Kingdom.

The result has been a series of continuing bilateral discussions with many of the countries; briefings to their delegations who come to Washington; arranging visits from these groups to our laboratories and contractor facilities; and, in some cases, a visit from and SDIO technical team to their country.

The object of these dialogs has been to address the various procedural concerns and to identify areas of SDI research for possible participation, consistent with U.S. law, security interests in protecting sensitive technology, and our obligations under the ABM Treaty.

In these discussions we have indicated our flexibility with regard to enabling mechanisms. In other words, there are a number of ways that the allies could participate in the program. Some allies are interested in concluding new government-to-government overarching or framework agreements which would provide a comprehensive basis for their country's involvement in the Strategic Defense Initiative Research Program.

Proceeding along these lines allows us to sort out the issues of principal concern to the allies and ourselves regarding their participation. Matters such as ensuring fair property rights, providing proper access to SDI information, maintaining strict industrial and technical security, and allowing fair competition with U.S. industry are but a few of the concerns foremost in all our minds.

Whether or not we conclude such overarching agreements, specific research projects will require separate implementing arrangements. These could take a variety of forms.

One could be an arrangement whereby we would enter into an agreement for cooperative research in which both parties would share in costs. The implementing vehicle in this case would be a government-to-government memorandum of agreement. Such cooperative arrangements can be particularly attractive and have potential since there are many cases where the United States and an ally are both working in comparable areas.

A more common form would be a contract awarded from the SDIO—or its agent, and by "its agent" I mean one of our military services—to an allied government, or government agency, sometimes on a sole source basis, but more normally on a competitive basis.

The allied government or government agency might, in turn, subcontract to its industry or laboratories. Allied governments, in this instance, would play a management or integration role.

We should also award contracts directly to allied industry, again on a sole source or competitive basis, as appropriate.

Finally, we believe there is considerable latitude for allied laboratories and industry to work directly with U.S. concerns on SDI contracts. We have already seen a great deal of interest in all these possibilities, from allies and from our own industry.

I would like to depart here to give you an example of that. We have recently gone out in a request for proposal for pointing and tracking experiments. This has created a great deal of interest in this country and overseas. We have received 33 proposals and, by the way, that is a number that exceeds the normal number of proposals in most contract solicitations by a substantial factor.

Seven of those involve foreign participation. All seven are from two countries, Germany and Great Britain.

Five of the seven proposals are just a foreign input directly, something that they feel that they can contribute and contribute directly.

Two of the seven are joint proposals with U.S. companies where they feel that their combined efforts can be more useful and offer us an attractive opportunity.

We are just now beginning the process of evaluating that set of proposals. I cannot say, of course, at this point in time, which would be selected or how they might fit, but it does indicate the scope and the type of effort we can anticipate in a purely competitive process, one which is quite consistent with all our procedures in the past.

It is important to point out that the fundamental basis for allied participation must be technical merit. We have made clear to allies that there can be no guarantee of a certain level of effort.

I should perhaps indicate one final possibility. Allies, particularly those with more limited national research capabilities, could be invited to send selected and appropriately cleared personnel who can make real contributions, to joint specified U.S. research teams in a scientific exchange program.

As you know, DOD already has a number of such exchange programs in place. Whatever the arrangement, we are taking vigorous steps to assure the security of the program and to safeguard all sensitive information and technologies. This is fundamental to any agreements that may be reached.

Briefly, I have tried to outline a few of the pertinent points with respect to allied participation in the strategic defense initiative. I would emphasize that United States and allied security remains indivisible. The SDI Program is designed to enhance allied security as well as U.S. security.

We will continue to work closely with our allies to ensure that, as research progresses, allied views are carefully considered and they are given the chance to take part. We have made a serious commitment to consult with our allies, and such consultations will precede any steps taken relative to the SDI Research Program which may affect our allies.

I would like to close with a statement made by Sir Winston Churchill more than 30 years ago when in addressing our Congress he said:

> Be careful above all things not to let go of the atomic weapon until you are sure, and more than sure, that other means of preserving the peace are in your hands.

Unfortunately, today the knowledge of nuclear weapons and delivery systems is already widespread. Moreover, our potential adversaries have more powerful nuclear and ballistic missile weapons capabilities than anyone else on Earth built into their forces, into their warfighting doctrine, and into their worldwide methods of intimidation and propaganda.

Thus to apply Churchill's advice at all, we must hurry and find that more effective means of keeping the peace. We believe that strategic defense offers the potential for a more secure and stable environment with far less reliance and utility placed on nuclear weapons.

With the SDI, we hope to make sure, and more than sure, that there are other and better means of preserving the peace.

Again, I thank you for the opportunity to appear today and welcome your questions.

[The prepared statement of General Abrahamson follows:]

PREPARED STATEMENT BY LT. GEN. JAMES A. ABRAHAMSON, DIRECTOR, STRATEGIC DEFENSE INITIATIVE ORGANIZATION

Thank you, Mr. Chairman, for the opportunity to appear before your committee and discuss the issues surrounding the very important subject of allied participation in the strategic defense initiative. I appreciate your interest in this matter and look forward to addressing your questions.

I would like to briefly review our program objectives and discuss a few of the salient points concerning deterrence and the part the SDI could be expected to play. I will relate this perspective to the allies and their role, as well as outline some of the areas that may hold promise for their participation. I'll conclude with a summation of activities in the allied arena and progress thus far.

A government's prime responsibility is to provide for the security of its people. We, along with our allies, have opted for deterrence of aggression as being the most certain course to assure this security and our survival as free and independent nations. The strategic defense initiative has significant potential to lend meaningful support to this course. The SDI has been structured as a program of vigorous research focused on advanced technologies for defense against ballistic missiles with the aim of finding ways to provide a better basis for deterring aggression, strengthening stability, and increasing the security of the United States and our allies.

Thus, the promise of enhanced deterrence is an elemental factor underlying the SDI. There are certainly other significant ways in which a defense against ballistic missiles will help to ensure against nuclear conflict. In the arms control arena, the SDI complements and supports U.S. efforts to seek equitable, verifiable reductions in offensive nuclear forces. Defenses could also provide protection against accidental missile launches or launches by some future irrational leader in possession of a nuclear armed missile. Additionally, the SDI program is a prudent hedge in the face of very aggressive Soviet research and development activities in strategic defense.

The President has said repeatedly that the SDI is intended to examine the potential for ballistic missile defense for the United States and for our allies. Today I would like to focus on the aspect of deterrence as it relates to our allies.

Deterrence requires that no doubt be left in the mind of a potential aggressor that the risks and costs of aggression far outweigh any gains that might be sought. In the words of Prime Minister Margaret Thatcher in her address to the Congress last February, "Our task is to see that potential aggressors from whatever quarter understand plainly that the capacity and resolve of the West would deny them victory in war; and that the price they would pay would be intolerable." We, together with our allies, have consistently pursued this course. In recent years, however, the concept of deterrence at the strategic level has focused almost completely on one approach, that is, posing to an aggressor unacceptable costs through the ultimate threat of nuclear retaliation. This almost exclusive reliance on the threat of retaliation with offensive forces—without the ability to deny an aggressor his objectives through defensive forces—has not always been the case.

Defensive systems are consistent with a policy of deterrence both historically and theoretically. In the 1950's and 1960's, enormous effort was devoted to strategic defense of North America. Every major city was ringed with Nike-Ajax and Nike-Hercules ground-to-air missiles and more than 2,500 aircraft were dedicated to air defense. This combined with allied and American retaliatory forces to provide a potent deterrent capability. When the Soviet emphasis shifted from bombers to the intercontinental ballistic missile, this defensive capability was allowed to decline since there were at that time no effective measures to defend against such missiles.

As we moved toward more dependence on offensive deterrence, we did so in full consultation with our allies, taking into account the other contributors or requirements for deterrence i.e. conventional forces and theater nuclear forces. The ultimate deterrent remains U.S. strategic offensive forces. We and our allies developed the strategy of flexibile response—the cornerstone of U.S. and allied security for almost 20 years. We in no way seek to discard this strategy, but rather look toward strengthening its very flexibility. As we look toward the future, the continuing growth and sophistication of Soviet offensive forces, as well as their defensive capabilities, would, if left unchecked an unanswered, rapidly place our deterrent capacity—as represented by U.S. and allied forces—in question, reducing or limiting the options so important to our flexible response strategy. The SDI offers the opportunity to shift the deterrent stance from this increasingly questionable foundation based primarily on the ultimate threat of devastating nuclear retaliation to one in which non-nuclear defenses play a greater and greater role.

As Secretary Weinberger has pointed out, "ultimately, we all must realize that in a nuclear world we share a common destiny and are united in our vulnerability to nuclear attack. That is why we must work together to bring our best minds to the formidable task of unlocking scientific knowledge that can unite us all in a world where no nation need fear the sudden advent of nuclear war . . ." This opportunity is manifested in a number of ways for both ourselves and our allies.

Such an approach would provide a far sounder basis for a stable and reliable strategic relationship. An aggressor's uncertainties regarding his offensive weapons' effectiveness would be markedly increased. This reduced confidence—because the U.S. and its allies would be more capable of denying an aggressor's military objectives—would make the aggressor much less likely to contemplate initiating a nuclear conflict, even in crisis situations. At the same time, this would mean a reduction in the utility, or perceived value, of ballistic missiles, which is a giant step toward rendering them impotent and obsolete. On balance, the likelihood of nuclear conflict would be vastly reduced, and that is the essence of effective strategic deterrence.

The foregoing, as well as most current discourse, does center on nuclear deterrence. While our allies have joined us in this present posture, there is, however, another facet of deterrence that may hold for them equal or even greater relevance. Too often, in the debate surrounding the SDI, the question of conventional deterrence is not in the forefront.

Of allied forces in Europe, for example, 95 percent of the divisions, 85 percent of the tanks, and 80 percent of the combat aircraft are provided, manned, and paid for by the European allies. Soviet doctrine seems to be evolving along lines that place ever greater value on tactical ballistic missiles and the havoc they could wreak on NATO forces. Soviet SS-20s and other shorter-range missiles presently provide overlapping capabilities to strike all NATO Europe, as well as our Asian allies. Their doctrine stresses the use of conventionally-armed (and possibly chemically-armed) ballistic missiles to initiate rapid and wide-ranging attacks on crucial military targets in order to cripple the ability to counter the initial thrust of a Soviet attack within, and to inhibit resupply and reinforcement from without.

So far, Soviet military planners have had a free ride on the use of ballistic missiles in any designs for aggression in a tactical application (just as they have in the strategic realm). Even a modest defense against tactical ballistic missiles would have a major effect on the situation. Not only would there be significantly increased costs for offensive forces to maintain the same level of advantage enjoyed today, but other technologies and the changing nature of operations and tactics would interact with defenses to create altogether more complex problems for the planner entertaining any thoughts of aggression.

By reducing or eliminating the military effectiveness of ballistic missiles, both tactical and strategic, defensive systems thus have the very real potential for enhancing deterrence against not only strategic nuclear conflict, but also against nuclear, chemical, and conventional attacks on our allies as well. Lieutenant General William Odom, Director of the National Security Agency, presented an excellent, insightful analysis of this issue entitled, "the implications of active defense on NATO for Soviet military strategy," to the European American institute for security research workship in November of 1984. I would like to offer a copy of that paper to the committee for inclusion in the record.

In reflecting on this very brief discussion of the promise offered by the strategic defense initiative to truly enhance deterrence and the role played both in the past and now by our allies, I submit that there is on substance to charges that the SDI threatens to "decouple" the United States from the security of our allies, or create a 21st century "Fortress America." The President envisions defense for both Americans and our allies. The basis for both U.S. and allied security will be one and the same—as it has historically been.

Turning to the steps taken by Secretary Weinberger inviting allies to participate in the program, we saw considerable scientific and technical expertise amongst our allies in their scientific and industrial communities. Certain allied contributions could reduce both the schedule and the cost of the SDI research program. Beyond the important technical contributions which allied participation may make, we believe that their involvement will certainly lead to a more indepth understanding of the program and the technical basis for defense as well as its military basis. This understanding will be a vital underpinning of a future decision to proceed into development. We have pledged to make that future decision in full consultation with our allies as well as to attempt negotiations with the Soviets. Moreover, allied participation will spark a latent synergism not only in defense against ballistic missiles, but also in the conventional arms arena.

There are many unique and important techncial capabilities that our allies can bring to the SDI research efforts—in some cases, it may be a meaningful technology base in certain areas, for example, the SDI directed energy research program. In this area, several of our allies have ongoing, advanced programs involving small, but very specific laser and particle beam research which could complement efforts underway in the U.S. In the field of optics, specialized high quality materials and advanced construction techniques are areas of research expertise found in several allied nations. There are also allies who have extensive programs involving gallium arsenide research, computer research, composite materials, electromagnetic launchers, and infrared sensors as well.

While the attraction of a different array of scientific talent is a powerful factor for our interest, there are also others—such as accesss to special facilities or teams of researchers with unique experience, or that have brought special techonology partway and taking it further may be useful for the SDI. In the climate of limited resources, every effort must be made to derive maximum benefit from our defense dollar. If certain jobs can be done more effectively, at less cost, or more quickly, in the hands of our allies, then it is incumbent on us as responsible managers to seriously consider such execution.

To derive the greatest benefit from allied expertise throughout the various SDI research areas and satisfy the need to keep them as fully informed as possible of the desirability of defense-oriented forces, the U.S. should proceed toward developing a meaningful allied role in SDI research—one consistent with our technical requirements, laws, regulations, and international obligations.

As the SDI program is moving ahead at a very rapid pace, our near term goal is to give our allies early opportunities to participate in SDI research. We initiated this process with the Secretary's invitation. It was sent to 18 of our allies—Australia, Belgium, Canada, Denmark, the Federal Republic of Germany, France, Greece, Israel, Italy, Japan, Korea, Luxembourg, Netherlands, Norway, Portugal, Spain, Turkey, and the United Kingdom. The result has been a series of continuing bilateral discussions with many of the countries; briefings to their delegations who come to Washington; arranging visits for these groups to our laboratories and contractor facilities; and, in some cases, a visit from an SDIO technical team to their country. The object of these dialogues has been to address the various procedural concerns and to identify areas of SDI research for possible participation, consistent with U.S. law, security interests in protecting sensitive technology, and our obligations under the ABM Treaty.

In these discussions, we have indicated our flexibility with regard to enabling mechanisms. In other words, there are a number of ways that the allies could participate in the program. Some allies are interested in concluding new government-to-government overarching or framework agreements which would provide a comprehensive basis for their country's involvement in the strategic defense initiative research program. Proceeding along these lines allows us to sort out the issues of principal concern to the allies and ourselves regarding their participation. Matters such as ensuring fair property rights, providing proper access to SDI information, maintaining strict industrial and technical security, and allowing fair competition with U.S. industry are but a few of the concerns foremost in all our minds. Whether or not we conclude such overarching agreements, specific research projects will require separate implementing arrangements. These could take a variety of forms. One could be an arrangement whereby we would enter into an agreement for cooperative research in which both parties would share in costs. The implementing vehicle in this case would be government-to-government memorandum of agreement. Such cooperative arrangements can be particularly attractive and have potential since there are many cases where the U.S. and an ally are both working in comparable areas.

A more common form would be a contract awarded from the SDIO (or its agent) to an allied government, or government agency, sometimes on a sole source basis, but more normally on a competitive basis. The allied government or government agency might, in turn, sub-contract to its industry or laboratories. Allied governments, in this instance, would play a management, or integration role. We could also award contracts directly to allied industry, again on a sole source or competitive basis as appropriate. Finally, we believe there is considerable latitude for allied laboratories and industry to work directly with U.S. concerns on SDI contracts. We have already seen a great deal of interest in all these possibilities—from allies and from our own industry.

It is important to point out that the fundamental basis for allied participation must be technical merit. We have made clear to allies that there can be no guarantee of a certain level of effort.

I should perhaps indicate one final possibility. Allies, particularly those with more limited national research capabilities, could be invited to send selected and appropriately cleared personnel who can make real contributions, to join specified U.S. research teams in a scientific exchange program. As you know, DOD already has a number of such exchange programs in place. Whatever the arrangement, we are taking vigorous steps to assure the security of the program and to safeguard all sensitive information and technologies. This is fundamental to any agreements that may be reached.

Briefly, I have tried to outline a few of the pertinent points with respect to allied participation in the strategic defense initiative. I would emphasize that U.S. and allied security remains indivisible. The SDI program is designed to enhance allied security as well as U.S. security. We will continue to work closely with our allies to ensure that, as research progresses, allied views are carefully considered and they are given the chance to take part. We have made a serious commitment to consult with our allies, and such consultations will precede any steps taken relative to the SDI research program which may affect our allies.

I would like to close with a statement made by Sir Winston Churchill more than thirty years ago when in addressing Congress he said, "Be careful above all things not to let go of the atomic weapon until you are sure, and more than sure, that other means of preserving peace are in your hands." Unfortunately, today the knowledge of nuclear weapons and delivery systems is already widespread. Moreover, our potential adversaries have more powerful nuclear and ballistic missile weapons capabilities than anyone else on Earth built into their forces, their warfighting doctrine, and into their worldwide methods of intimidation and propaganda. Thus to apply Churchill's advice at all, we must hurry and find that more effective means of keeping the peace—we believe that strategic defense offers the potential for a more secure and stable environment with far less reliance and utility placed on nuclear weapons. With the SDI, we hope to make sure, and more than sure, that there are other and better means of preserving the peace. Again, I thank you for the opportunity to appear today and welcome your questions.

Senator **WARNER**. Thank you, General Abrahamson.

General **ABRAHAMSON**. I would add in the early part of the testimony, the part that I skipped, there is a discussion in which our security is tied very carefully, both in conventional deterrence and in nuclear deterrence to the U.S. capability and in that portion I referred to a paper originally done by Lt. Gen. William Odom, U.S. Army, and updated in February 1985.

Several copies of these have been distributed to the members of the subcommittee. I recommend it as a very thoughtful strategic piece on the relationship of defenses in Europe to offenses.

I offer that.

Senator **WARNER**. Without objection, that will be included in the record as well as your complete statement today.

[The paper by General Odom follows:]

EUROPEAN AMERICAN INSTITUTE FOR SECURITY RESEARCH

(Prepared by William E. Odom, Lieutenant General, U.S. Army)

THE IMPLICATIONS OF ACTIVE DEFENSE OF NATO FOR SOVIET MILITARY STRATEGY

(Prepared for the European American Institute workshop on "West Europe and the Future of Active Defense and Long-Range Offense," Washington, D.C., 16-18 November 1984)

A certain temerity is required for a Western analyst to address this topic. To do it properly, he should have a fairly accurate knowledge of Soviet military strategy and war plans. He should know a great deal about Soviet missiles and aviation, particularly technical characteristics of their performance. Finally, he needs to judge quantitative interactions between NATO and Soviet forces with and without active defenses for NATO. Clearly such knowledge is not available in the fullness we would like it, and what is available is not adequate for final judgments.

We can, nonetheless, determine whether Soviet military planners are likely to see active defense of NATO as having little significance for the Soviet Union—a trivial factor in face of offensive forces—or whether it would compel them to make major changes and throw doubt on their offensive strategy for war.

The approach here will be to dwell initially on Soviet strategy, doctine, and weapons and then to ask what differences defenses might make in the calculations of Soviet planners. The aim is modest: to demonstrate that active defense is not trivial for Soviet strategy, that it could alter significantly the Soviet estimate of the prospects for a successful attack on NATO.

SOVIET OFFENSIVE STRATEGY FOR EUROPE

We are at present witnessing a second major change since WW II in Soviet strategy and doctrine for offensive warfare. The first, inspired by what the Soviet planners call the "revolution in military affairs," was marked by Sokolovsky's 1962 volume, Military Strategy. It took account of three new technologies and the implications of each for the nature of future war. Rocketry, nuclear weapons, and cybernetics brought such dramatic change to the character of war, in the Soviet view, that a virtual revolution was required in Soviet doctrine, strategy, and force planning. The scope of warfare would be global, massive firepower could be delivered at intercontinental and full theater ranges in minutes and hours, and the requirements for maneuver with both fires and forces would be enormous, on a scale heretofore inconceivable.

The next 20 years saw the Soviet armed forces expand qualitatively and quantitatively in unprecedented degrees. Until the late 1970s, Soviet open writings gave the impression that a conflict in Europe would involve nuclear weapons very early. Much Western analysis either emphasized that about Soviet doctrine or insisted that selective and limited use were technically unfeasible, thus reinforcing this public view of the Soveit posture. As Trulock and Gouré make clear in another chapter of this volume, Soviet military circles already in the late 1960s were exploring extensively the prospects for selective and purposeful use of nuclear weapons to support military operations within strong political guidance. Their case is based on a great deal of recently available Soviet classified materials. Many of their conclusions have long been supportable by inferences from open sources and Soviet force developments, and a number of authors have reached those conclusions but in face of much skepticism and criticism. Trulock and Gouré will be far more difficult for serious skeptics to doubt. For our purposes here, however, the important insight is that the so-called "revolution in military affairs" announced by the Soviet military in 1950s and 1960s had as its logical development the trend away from massive and indiscriminate use of nuclear weapons toward targeting as part of Soviet "combined arms doctrine."

That trend has not ended, but it is competing with a parallel second postwar shift in Soviet military affairs. Once again, a triad of new technologies are affecting Soviet views of changes in military affairs: microcircuitry, directed energy systems, and genetic engineering. Marshal Ogarkov seems to have been a key figure in leading the new developments because they are coincidental with his emergence as Chief of the General Staff in 1977. In an interview with "Red Star," [1] Ogarkov declared that new weapons technologies have altered the character of war sufficiently that a global strategic conflict is conceivable in which nuclear weapons would not be used. The effectiveness of advanced nonnuclear weapons could make it unprofitable to resort to nuclear weapons.

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[1] Footnotes at end of article.

Microcircuitry and directed energy systems are the technologies that make "smart munitions" possible as well as deliverable at long ranges with great accuracies. Genetic engineering is far less certain in its possible military applications; it may prove to have few or none, but it seems to attract great Soviet attention in scientific circles and international fora. It is not at once obvious why these new technologies have created such a dramatic sense of change in the USSR. Perhaps it is fear of the West's lead in their applications. Perhaps it is the significance for Soviet industry. Perhaps it is frustration at having built a large military force to cope with the 1950s triad of technological concerns only to see them possibly declining in relative importance. It is probably all of these, and we can better understand their reactions if we think about the Soviet solution to the problems they saw created by nuclear weapons and rocketry.

Rocketry and long-range aviation permit unlimited depth for fire support. Nuclear weapons permit great destruction of massed forces. These two realities formed the basis for Soviet doctrine and force development. First, to make their own forces less vulnerable to nuclear weapons, they planned to spread them out as evenly as possible over the entire depth of their own territory. They did this by "echelonment." To achieve the necessary mass for penetrations of the enemy's defenses, they planned on a high speed attack, all echelons rolling forward rapidly. That would cause combat power to pile up at the line of contact where the enemy would be reluctant to use nuclear weapons. As the first echelons found weak points, subsequent echelons could be guided through for deep penetrations.

Second, they had to develop a means of fire support that could attack the full depth of the enemy's rear. The purpose of this support would be to destroy first of all the enemy's nuclear means, then his command and control, and finally, his reserve forces, or at least to make it difficult for them to be brought to bear against Soviet penetrating forces.

The beauty of this doctrine, as John Erickson [2] has pointed out, is that it permits or requires a "combined arms" operation which can be conducted at both the nuclear and nonnuclear levels without significant change. The doctrine without the means to implement it, however, would leave the beauty unrealized, a point emphasized by Trulock and Gouré. New technologies actually affect the character of war when they are deployed in quantitatives that can make a difference. The set of Soviet military programs carried through from the 1950s to the mid-1970s are much easier to understand when viewed in this doctrinal context. The maneuver forces are fairly well known—a large inventory of tanks, infantry fighting vehicles, artillery, combat engineer equipment, mobile air defenses, signal means, and logistical means. The fire support forces are more important to our concerns in this essay.

Stephen Meyer has provided us with the most comprehensive open source study of those forces available.[3] From his analysis and his catalogue of Soviet ICBM, IRBM, SLBM, SLCM, and aircraft programs,[4] we can see that the 1950s' "revolution in military affairs" inspired fire support programs that promised coverage to the full depth of the theater of war. Similar evidence of Soviet intercontinental nuclear forces can be found in the official publication of the Department of Defense, "Soviet Military Power." [5] In this first set of programs, however, the quality of the systems was poor in accuracy, speed of operation, and a number of other performance characteristics. Nuclear warheads had to be large to offset inaccuracy.

By the late 1970s, accuracy and other problems were being overcome, but the quantitatives of the improved systems were still small. Not surprisingly, a massive modernization program was set in progress and continues today. In almost every case, there were no essentially new systems but only qualitatively better systems. SS-20s appeared to cover SS-4 and SS-5 missions; SCALEBOARD, SCUD, and FROGs were being replaced by SS-22, SS-23, and SS-21 models. A similar pattern is found in aviation and SLBMs. The single rather new theater development is the cruise missile, and even it is not new in principle for Soviet forces. New guidance and propulsion technologies simply give cruise missiles possibilities wholly unknown in the earliest models found in Soviet inventories.

In ICBMs, of course, we are seeing the early stages of Soviet programs for mobile ICBMs. In silo based systems we see modernization but not a force expansion. The expansion appears to be coming in mobiles and variations of cruise missile launchers—air, sea, land.

The important point to draw from these data is that the first period of Soviet force building, up to the late 1970s, involved a sizing of Soviet forces for fire support. While we do not know in all the particulars of how Soviet planners arrived at the answer to "How much is enough?", we can make some rough inferences on that account. Stephen Meyer offers a rather compelling analysis of Soviet force sizing. He uses a couple of Soviet analytical models, takes account of their professed target priorities, and concludes that the full set of NATO targets could be covered by Soviet theater nuclear forces before the SS-20 was deployed.[6] This force sizing, of course, was done against a NATO which had no active defenses, except air defense, and with very little passive defense.

The sizing of intercontinental forces has not been analyzed in the same way in open sources, but unless the Soviet approach to the task is systemically different from sizing theater forces, one rought inference seems justified: The ICBM forces in silos have levelled off in numbers. The same is probably true for SLBMs and bombers but much less certain. ICBM expansion will apparently come in mobiles. This may seem puzzling, but from a Soviet doctrinal viewpoint it is not. Soviet planners remain obsessed with the "initial period" of a war. Because it is judged to be decisive for the eventual outcome of the war, the General Staff clearly wants to dominate that period. Their terminology for this outcome is achieving a radical shift of the "correlation of military forces" in favor of the USSR. There will be subsequent periods, perhaps lasting months and years, but the initial period can well cast the die for the final outcome. The level of strategic nuclear forces reached in the late 1970s, therefore, probably equals what the Soviet planners believed is necessary for a decisive shift in the "correlation of military forces" in the "initial period." Mobile ICBMs and other new systems—possibly cruise missiles and bombers—are quite naturally the arsenal of deep fire support for the subsequent periods of a global war. Finally, it should be noted that this sizing of strategic forces was probably based on no strategic defense in the U.S., active or passive.

Precisely where the present modernization programs will take Soviet force structure is not entirely clear, but if we keep in mind employment doctrines for both maneuver forces and fire support forces, we get some interesting insights. Marshal Ogarkov has emphasized again and again the need for a "theater strategic operation," and operation composed of multiple fronts and encompassing continuous combat to the full depth of a "theater of military activities." [7] In his articulation of this concept, we get a sense of an offensive that is designed to seize Western Europe in a much shorter time, weeks, not months. Such an operation clearly must be supposed by highly coordinated fires affecting all adversary forces that could be brought to bear in the theater. In light of the U.S. commitment to NATO of ten divisions in ten days, it is obvious that Soviet targeting would include trying to prevent that reinforcements. Thus, Soviet strategic target sets may not include just U.S. ICBM fields and economic targets. In the "initial period" in Europe, U.S. land forces are critical variable in "correlation of military forces." Many targets in the U.S. could be ignored for a few days or weeks; not so land forces enroute to Europe.

These points about Soviet targeting and force sizing are essential to understand if we are to appreciate the impact of active defense in NATO, including the U.S., in initial exchanges. The dynamic dimension is also important. The Soviet choice of a target set will change as the war scenario varies. During a conventional phase of the war, Soviet conventional means will seek to degrade NATO's nuclear forces. Thus, the active and passive defense of NATO nuclear systems will be significant for the subsequent nuclear phase. For certain contexts the Soviet planner will deal with calculations of TNF alone, but he will always put them back in the context of "combined arms" doctrine and a war extending beyond an initial period.

SOVIET STRATEGIC DEFENSES

Soviet offensive forces have not grown alone without a defensive counterpart program. The massive Soviet high-altitude air defense system has always puzzled Western analysts who assume an objective inescapability about the nature of "mutual vulnerability." Much the same can be said about Soviet civil defense. But with the emerging low-altitude air defense deployment, the SA-10 and the look-down-shoot-down figher interceptor capability, it is difficult to remain puzzled: the Soviet leadership simply takes strategic defense seriously, not only active, but also passive defenses. Does it make sense to deploy all these defenses without an ABM cap over them? That is difficult to answer without a way to calculate the significance of passive defense, especially dispersal and sheltering. Because the U.S. strategic force level has remained more or less static for several years, while Soviet passive and active defenses have grown steadily, it has to be assumed that some degradation in U.S. damage expectancies has occurred. And it is also important to note that the

Moscow ABM system, if it proves even marginally effective, covers many high-value targets: command and control, political leadership, and military industrial.

There are some signs that the USSR might indeed put an ABM, as well as an ATBM, cap on homeland strategic defense. Sayre Stevens draws this conclusion in his analysis of recent reports of the Soviet SA-X-12 having an ATBM and possibly an ABM capability, or at least the potential for such a capability.[8] Most troublesome is the mobile nature of upgraded SAMs for ATBM and ABM. Not only would they be more difficult to locate and suppress, but they would also be difficult to call a violation of the ABM treaty, particularly if Soviet authorities refused to admit the ABM potential. "Creepout" is probably as much greater threat on the Soviet side than "breakout" from the ABM treaty.

The central conclusion that we should draw from a look at Soviet strategic defensive force building is threefold. First, Soviet military planners take defense seriously, very seriously, enough so that they allocate large resources to defense programs, both active and passive. Given the Soviet record for calculation in every other aspect of force building, many calculations must suggest to them a compelling case, not only for strategic defense, but also for determining what defenses to deploy. Second, active defenses are not considered alone. They are part of an overall concept of defense, including passive means and active systems, as well as degradation of NATO's offensive nuclear systems with conventional "combined arms" operations. Third, strategic defense is part of any Soviet calculation of the overall correlation of military forces. Today that calculation includes only air defense in the list of NATO "active" defense measures. Any change in the defensive posture of the NATO states is bound to affect Soviet calculations. If they take defense seriously for themselves, they must take it seriously for their adversaries, probably more seriously.

WHAT DIFFERENCE DEFENSE MIGHT MAKE

If we assume the position of Soviet planners who hold the foregoing view of future war, required forces, and war plans, and if we ask what difference active defenses are likely to make, the first question we probably would want to answer is whether such defenses could really make a big difference. Are they something that would significantly affect our offensive strategy and force levels? And, of course, we would want to know when such defenses could be deployed. If it is not until the next century, then the significance will be trivial in the remainder of this century, leaving us quite a long planning horizon.

Soviet TNF capabilities inventory

From the foregoing analysis of Soviet doctrine for general war, particularly how it would unfold in Europe, we can assume that Soviet planners have sized their theater nuclear forces to deal with the present target set in NATO. According to Meyer, this is "about 280 individual targets, of which 100 could be regarded as time-urgent, with 50 of the latter being hard point targets."[9] Taking into account the kind of target and the reliability of the systems, the early 1970s Soviet TNF inventory consisted of 472 SS-4s, 90 SS-5s and 120 SS-11s (ICBMs used for theater missions). The force provided between 353 and 472 deliverable warheads in light of reliability factors. When attack requirements for the different kinds of targets are included, and when aviation is also included, Meyer's analysis suggests that the introduction of the SS-20s has not changed the damage expectancies for Soviet planners against NATO. Rather they have made complicated attacks easier, improved planers' confidence, provided margins of forces so that a preemptive strike would not have the effect of consuming the entire Soviet TNF inventory, and allowed reduction of collateral damage. Depending on reliability, between 420 and 639 SS-20 warheads on SS-20s are available (this assumes 240 SS-20 targeted against Europe). While Soviet planners have some margin in numbers of warheads, even the new systems do not give them four or five times the number of warheads needed for a full coverage strike. Of course, the continuing growth of the SS-20 force, including reloads, means this is not a premanent condition. It cannot, however, change overnight or cheaply.

Western active defense technology and applications

Picking up "Ballistic Missile Defense",[10] Soviet planners could get a fairly clear picture of available technologies for deployment in this century, and they could determine what applications we believe are most effective and most feasible. As the chapter by Stephen Weiner asserts, "Given the current state of technology, reentry BMD systems have the lowest technical risk. . . ."[11] In other words, endoatmospheric systems are feasible, probably well within NATO's capability to deploy in the 1990s. These systems would, therefore, worry the Soviet planner most.

Our Soviet planner would also note that Weiner concludes that "The job of defending redundant hard targets such as missile silos is much easier than defending cities. . . ." [12] In other words, he would be very interested in what NATO chooses to defend actively because the targeting problem could inherently be easier or harder. A NATO effort to defend cities or other broad area targets would not likely disturb the Soviet planner deeply. Carefully selected military capabilities which are critical to NATO military operations, however, would galvanize his attention.

Ashton Carter's study of BMD applications [13] provides a thorough review of the various kinds of BMD systems used in a variety of defense missions. For our Soviet planner, his most important observation is that "Virtually everyone concedes that BMDs can be made that would force the attacker to double up—a price of two RVs—to destroy a defended target even if the attacking RVs were perfectly accurate and reliable. Within the two to eight range there is lively debate." [14] What does it take to force the attacker to double up, that is, use two RVs per target? "If the defense only succeeds in making its single intercept more often than it fails, the offense will conclude that it makes better use of RVs by targeting two RVs at a lesser number of defended aimpoints than by targeting one RV at each of a larger number." [15] This is demonstrated by assuming that the attacker has 1,000 RVs to use against 1,000 targets, each defended by BMD. If the BMD succeeds 51% of the time, a one-on-one attack of all 1,000 targets will achieve at best 490 kills. A two-one-one attack will kill 500. Thus, sober calculation leads to the targeting of only 500.

The Soviet planner would see at once that a BMD system is technologically feasible today which would force him to resort to two-on-one targeting at a minimum. Of course, he already knows this, from his own programs, but now he can see NATO attention possibly turning to a serious review of these technical insights.

We are taking an extremely conservative view of technology in this instance. We are only considering one layer of defense, terminal defense of militarily significant targets. We are not betting on high risk or future technologies but rather things that could be fielded in the next decade or less, probably a lot sooner. Adding a second layer of defense to deal with the "mid course" of ballistic missiles is also feasible with nuclear warheads in the interceptors, and in light of the Army's recent test results with a nonnuclear shot at an incoming RV, a nonnuclear overlay defense can no longer be relegated to the next century. Once we move to a layered defense, of course, we are able to talk about charging much higher attack prices, three- to eight-for-one, perhaps more.

Soviet modeling for TNF requirements

Next, the Soviet planner would want to explore the sensitivity of his own sizing requirements to possible NATO active defenders. Soviet planners have shown a strong affinity for analytic modelling in military affairs. In fact, the Soviet military has been alleged by some to have more game theorists than any other army in the world. Stephen Meyer has examined a couple of analytic models which appeared in Soviet closed writings, models which inspired criticism and debate that reveal a great deal about the variables Soviet military planners take most seriously in force planning.[16]

The first is called the model for Correlation of Nuclear Forces. Developed in the 1960s, it used variables for EMT (equivalent megatonnage), penetration probabilities for both Soviet and enemy delivery systems, and survivability for both Soviet and enemy systems. In the ensuing closed Soviet discussions,[17] criticism focused largely on the variables in the model, the extent to which they could be determined empirically hidden complexities, and so forth. But it did not dismiss such modeling. Rather the attempt was to improve it.

The model formula was:

$$C = C_o \frac{\Sigma \sqrt[3]{U_j}^2 \cdot Pi \cdot Si}{\Sigma \sqrt[3]{U_j}^2 P_j S_j}$$

where:

C_o = the initial correlation of nuclear forces defined as the total deployed EMT of Soviet nuclear forces divided by the total deployed EMT of enemy nuclear forces.

U_i; U_j = the fraction of Soviet megatonnage carried by a given type (i) of delivery system; the fraction of enemy megatonnage carried by a given type (j) of delivery system.

P_i; P_j = the penetration of a given type (i) of Soviet delivery system; the penetration probability of a given type (j) of enemy delivery system.

S_i, S_j = the survivability probability of a given type (i) of Soviet delivery system; the survivability probability of a given type (j) of enemy delivery system.

The main variables, U, P, and S, are complex and require extensive empirical data and calculations if the model is to be used. For our purposes here, we merely need to be concerned with P_i, that is, the penetration of the Soviet delivery systems. The Soviet author let the Soviet side attack first, aiming first of all to destroy the enemy's TNF, but also other targets. The enemy then retaliates, requiring a second calculation, and yielding a value for C that represents "the relative potential of the two residual nuclear forces to destroy target arrays similar in composition and area." [18]

If we assume that such a set of calculations is made to yield some value for C in which no active defense (except present air defenses) exists in NATO and then repeat that calculation for the cases where NATO has active defense that will kill ballistic missile RVs, we will see the effect on a Soviet planner's calculation of the consequences of that deployment. All other things being equal, C will decline in direct proportion to the value of P_i, the probability of penetration, which is a function of NATO defenses. As P^i drops from 0.8 or 0.9 to the 0.3-0.5 range, C is roughly halved.

BMD systems which could charge a price of two-for-one instead of one-for-one, therefore, could lower the value of P_i by one-half for the target set such a system defends.

As Meyer points out, this model, presented by the Soviet author, I. Anureev, received much criticism by other Soviet analysts. "It did not provide either a relative or absolute measure of the effect of a preemptive nuclear strike on the enemy, or friendly capabilities. In other words, a residual of 5 to 1 might still leave the enemy sufficient TNF to annihilate a major portion of Soviet ground forces and logistics networks."[19]

A few years later, a model designed to meet most of the criticisms was introduced. N. Zubkov's "Control Effectiveness Model" encompasses "the capabilities of reconnaissance, target acquisition, C^3, command decision-making, crew responsiveness and weapons readiness." [20] The formula for this concept is:

$$K=\frac{\Sigma m_i . P_i \sqrt[3]{q_i^2}}{\Sigma n_i \sqrt[3]{q_i^2}}$$

where:

n_i = total number of enemy nuclear weapons of a given type (i).

q_i = the average nuclear yield of enemy nuclear weapons of a given type (i).

m_i = the number of enemy nuclear weapons of a given type (i) that can be detected by Soviet reconnaissance capabilities.

P_i = probability of destroying a given type (i) of enemy nuclear system prior to its launch given it is located by reconnaissance.

The value calculated for K is the expected fraction of the enemy's EMT that could be destroyed. Meyer demonstrated what it might have produced in the early 1970s when NATO had about 670 EMT available for TNF missions. Assuming Soviet preemptive strikes "catch 85% of NATO land-based aircraft on the ground and 100% of carrier-based aircraft, then K would be about 0.60 leaving a residual NATO capability of 270 EMT deliverable by remaining aircraft, Pershing IA and Polaris/Poseidon SLBMs."[21] The model also allows a planner to deal with periods of convention conflict in which nonnuclear systems could attack the adversary's nuclear systems, thus degrading his TNF before the nuclear phase. But it is a model only for analyzing preemptive strikes, and it will lead to choosing a force that maximizes effectiveness for that mission.

In our considerations here, however, that is precisely what we want to examine. What would NATO active defense imply to the Soviet planner? How would he see its effect on his calculations of his force needs?

Two points are fairly clear in this regard. First, the value of P_i will be affected by NATO active defense. The example calculation offered by Meyer for the early 1970s would have come out considerably lower, approaching double the size of the remaining NATO EMT if a two-for-one price had been charged against the SS–5 strike.

Second, the value of m_i should attract our attention. Among other variables, the Control Effective Model is sensitive to reconnaissance. What Soviet recce cannot find, Soviet TNF cannot hit except by random chance. Mobile targets, therefore, become a problem if they cannot be found, and among the many scenarios a crisis period leading to war could take, the prospects for losing knowledge of locations are considerable. Active defenses could threaten some kinds of Soviet recce, particularly space-based intelligence acquisition systems, and of course they would threaten recce aircraft. As the value of m_i declines, the Soviet planner must find means and resources to compensate for it.

By no stretch of the imagination should we conclude that these two models for Soviet TNF sizing are the one actually used today. They were, however, taken seriously in the 1970s, and they offer the best insight we have in open sources into how the Soviet planners think about the TNF problems, what variables they see as critical, and what kinds of forces such modelling encourages them to build. The Correlation of Nuclear Forces Model would have dictated a large aviation buildup because it did not give special significance to time-sensitive target sets. The Control Effectiveness Model encourages one to buy time-urgent forces, that is, ballistic missiles. Both models can be used and the insights for force-building from both can be compared and used to achieve a mix of purposes. In light of the subsequent SS–20 deployment, one is inclined to believe the Control Effectiveness Model had something to do with the Soviet decision to build a more capable IRBM before expanding and modernizing frontal aviation.

If we take the indications from the models that NATO active defense would create—sharply declining values for both C and K, and if we assume, as Meyer did, that Soviet TNF has been sized for a more or less undefended NATO target set, then the Soviet planner will be impressed that he has a serious problem. The seriousness of it will be underscored if those NATO defenses are applied to NATO TNF and C^3 assets, not to cities and broad area targets. We see little interest on the Soviet side in a "countervalue" approach to using TNF. Rather Soviet planners are primarily concerned with military targets and even with minimizing collateral damage in light of their postwar interests in the economic prizes they hope to capture in Western Europe.

The answer to "what difference do active defenses make?" from the Soviet viewpoint, then, is "a lot." And the answer is derived from looking through the analytical spectacles of his analytical models, not ours.

WHAT CAN THE SOVIET PLANNER DO ABOUT ACTIVE DEFENSES?

The conventional wisdom has long been that the Soviet planner can easily overwhelm active defense by piling on more warheads. The foregoing analysis should raise strong doubts about that as either the only solution or an adequate solution.

First, he does not have the stockpile of warheads to overwhelm even a terminal defense system except in limited points. To concentrate on some targets will mean he must give up others. Before he will do that, he will try to determine what that will mean for the overall campaign, including fire, strike, and maneuver forces, nuclear and nonnuclear. Recent Soviet public discussions of the U.S. Army's "air-land" battle doctrine indicates that Soviet military planners see an expanding array of deep targets and a changing operational environment requiring across-the-board modernization of their doctrine and forces. Major General I. Vorobyev sees precision guided munitions against deep targets as making the competition to gain the advantage in "fire" take precedence over some of the efforts to gain it in "maneuver." [22]

It would be easy to say that our Soviet planner simply has to double his TNF capability to neutralize active defenses in NATO. It is not that easy or cheap for him, however. He must worry about BMD improvements that drive the exchange prices much higher than two-for-one, and he must be concerned about degradation of his reconnaissance. This becomes particularly acute as a problem when he begins to worry about the many mobile deep fire systems that might hit his TNF with nonnuclear munitions. In other words, he understands that the European theater does not permit isolation of the combined arms combat from ballistic missile exchanges.

Another standard argument, that penetration aids and decoys could be used to neutralize the defense or degrade its capability significantly, is also not compelling. Our Soviet planner needs all the warheads he can get. He is unlikely to surrender throwweight capacity to penetration aids in the theater context. At least until he builds many, many more TNF systems, multiplying his throwweight manyfold, it does not make much sense.

Our Soviet planner would, if his models are any clue, also be concerned about passive defense, e.g., hardening of c^3, air fields, and nuclear storage. The variable, P_p, to be fully developed, would include some added value for hardness as well as for active defense. Thus, unless we also know that added value, we cannot know how much of what kinds of added offense would be needed to offset it, but it is not likely to be trivial.

It seems very conservative to infer, therefore, that our Soviet planner would have to buy several times his present level of TNF capability as well as try other means of attack. Eventually he might regain the present correlation of forces, but he could not do that overnight. It could easily take a decade or more. Buying 10–15 years of credible defense is not to be dismissed lightly. Permanent and timeless defenses—or offenses—are not real options. A ten-year interval in the changing context of military technologies and strategies is a long time.

Of course, there is always the issue of comparative costs. Will active defenses cost NATO more to deploy and maintain than it will cost the USSR to counter with offensive forces? In the present conditions of TNF balances, the conventional view, that defense costs a lot more, may not be valid. Particularly as the Soviet planner sees a variety of other technologies complicating his problems for both defense and offense, e.g., "smart" munitions, then calculations become more complex. The answer is far from obvious, and it may be the opposite of conventional wisdom.

An answer to the comparative cost question also would seem to have to take account of Soviet planners' willingness to buy active defense for themselves. If it is not worth it, why do Soviet planners buy active defense so massively? Air defenses in the USSR are enormous, and we see expansions still occurring. We see billions of rubles of investment in the Moscow ABM system, not to mention the large peripheral radars. For force developers whose resources are far more constrained than NATO's, these active defenses must mean a great deal. The obvious answer, although not very popular in the West, is that strategic defense really matters, that Western notions of unavoidable vulnerability are not sound.

ACTIVE DEFENSE FOR NORTH AMERICA

Thus far we have dealt largely with Soviet TNF for Europe, not with ICBMs, SLBM, aviation, and cruise missiles against the North American continent. Unfortunately, no Soviet analytical models for intercontinental exchanges are available to give us a purely Soviet perspective. A few observations are possible, however, that might reveal something of a Soviet perspective on that dimension of the active defense issue.

Air defenses clearly are feasible, but the U.S. and Canada do not possess anything like the Soviet air defense capability. This has been due to the lack of a large Soviet bomber threat. That condition is changing with the new Blackjack bomber. It has already changed insofar as Cuba's role in a general war. Cuban MIG–23 aircraft, over 40 in number today, create an air threat to the Southeastern U.S. A large part of U.S. ground forces for Europe come from that region. Soviet reinforcement of aviation based in Cuba could occur in a crisis, changing the situation radically.

Submarine launched cruise missiles, a threat now emerging, create another type of air defense problem up and down both the East and West Coasts of North America. While active defense against them would be expensive, it is certainly feasible.

Active defense against any of these threats would unavoidably have a significant impact on Soviet planners. It would put them back in their old box where an attack of any significance on the U.S. would have to be by ballistic missiles. Aviation and cruise missiles with nonnuclear weapons may be what Ogarkov had in mind when he spoke of a global war in which nuclear weapons are not used. ICBMs and SLBMs with nonnuclear warheads, even with great accuracies, do not promise much return on the investment. Some kinds of active defense, therefore, clearly would make a big difference to the Soviet planners.

BMD would make a difference, depending on what it defended. Were selective use of BMD applied to C^3 and means of force projection (that is, airlift, sealift, and general purpose forces destined for Europe), that could have a strong bearing on Soviet calculations of the force balances during a war in Europe. At present, when there is no BMD in the U.S., very limited Soviet strategic targeting could prevent the U.S. from projecting forces to Europe on the NATO schedules. The impact on what the Soviets call the "initial period" of a war would be great, possibly decisive.

The popular Western concern for intercontinental counterforce exchange calculations, even the obsession with them, prevents most Western analysts from considering other and more modest target sets. Yet from a Soviet "combined arms" perspective, they are very likely to think about them first. And, as Trulock and Gouré point out, there is growing evidence that in fact they do. Moreover, given their lesser confidence in the reliabilities of technology, they would be much less inclined to engage in large "spike" attacks against ICBM fields where some kind of failure could cause them to waste large parts of their costly and precious strategic forces. Trials with smaller sets of warheads would clearly be more in line with the Soviet bias. This becomes more compelling when we remember that Soviet planners are investing heavily in strategic defense, something that makes sense only if they believe they must ride out a large U.S. strike and survive with some military capabilities.

CONCLUSIONS

As admitted at the beginning of this essay, a full answer to the question of implications of active defense for Soviet strategy requires knowledge of Soviet war plans, weapons capabilities, and quantative force interactions that we do not have. We do see, however, enough of changing Soviet military doctrine and force structure to draw some fairly congent inferences. The following set of inferences seem to stand out:

Because the Soviet planner has had a free ride with his TNF, NATO active defense deployments, even the most modest terminal defense systems, would have a large impact on him. Not only would he have to pay the increase in offensive forces for TNF, but other technologies and the changing nature of operations and tactics will interact with active defenses in Europe to create quite complex problems for him.

Active defenses in North America would not solve many of the problems Western analysts find with leakage and so forth, but for the Soviet planner, they would create two kinds of difficulties. Air defenses would preempt the free ride he hopes to get with bombers and cruise missiles. BMD, depending on what it defends, would complicate his planning for winning quickly in Europe. The Soviet planner shows little sign of being concerned with the same problems that concern many of the authors in the Carter and Schwartz volume. Soviet planners are not interested in destroying U.S. cities. They are interested in capturing Europe and probably the two other major contiguous theaters.

The deployment of active defenses for NATO, in the Soviet planner's mind, would presage many other things. First, it would be seen as the beginning of defense improvements that would lead to others, more effective, more troublesome. Second, it would reflect a different Western psychological attitude to modern warfare. The concept of mutual vulnerability, upon which Soviet negotiators and planners have traded without accepting for their own planning, could no longer be expected to constrain Western force development. That would be a dramatic change for both political and military leaders in the USSR.

The Soviet planner would be terribly worried about two other dimensions of competition. First, in R&D, where the West is strong, he would now be up against a new Western challenge. Second, the areas of competition would be spread, cause him to be faced with allocating his lesser resources to a greater variety of endeavors both in R&D and industrial production. The situation heretofore has allowed him to compete with the NATO states in offensive forces only, to proceed at his own pace in defense. Henceforth, he would have to divide his efforts for a two-front competition instead of one.

Finally, active defense (and passive defense) takes the military interaction into all the complexities of "combined arms" operations, especially in Europe. That is, we cannot separate them out the way we have so often done in dealing with calculations about strategic forces exchanges. Other variables, like reconnaissance, maneuver forces, and nonnuclear fire support and strikes, enter the equation, making many of the traditional Western analyses inadequate to deal with them.

In many ways, events have moved past NATO. Active defenses already play a big role for the USSR. The issue may not be whether they make a difference so much as whether or not the Alliance is going to act to improve its active and passive defense.

FOOTNOTES

[1] "Red Star," May 9, 1984.

[2] The College Station Papers," 2: "Soviet Combined Arms: Theory and Practice" (College Station: Center for Strategic Technology, Texas A&M University, 1980).

[3] Stephen M. Meyer, "Soviet Theatre Nuclear Forces, "Adelphi Papers" 187 and 188, Winter, 1983/84.

[4] Ibid., No. 188, especially pp. 54-57.

[5] See "Soviet Military Power," pp. 19-39, in the 1984 edition.

[6] See especially Meyer, No. 188, p. 26.

[7] "Always Ready to Defend the Fatherland" (Moscow: 1982), p. 33ff was the first full description of the concept of the "theater strategic operation," but Ogarkov mentions some aspect of attaining that capability in almost every public article.

[8] See Sayre Stevens' essay on "The Soviet BMD Program" in "Ballistic Missile Defense," Ashton B. Carter and David N. Schwartz, eds. (Wash, D.C.: The Brookings Institution, 1984), pp. 214-220.

[9] Meyer, No. 188, p. 25.

[10] Ashton Carter and David Schwartz, eds.

[11] Ibid., chapter 3.

[12] Ibid., p. 97.

[13] Ibid., chapter 4.

[14] Ibid., p. 112.

[15] Ibid., p. 119.

[16] Meyer, No. 187, pp. 34-44.

[17] The discussions were in "Military Thought," a Soviet classified journal which is available in Western libraries in parts of the serial.

[18] Meyer, No. 187, p. 39.

[19] Ibid., p. 41.

[20] Ibid.

[21] Ibid., p. 43.

[22] "Red Star," Sept. 15, 1984.

Senator **WARNER**. Thank you, gentlemen.

If there is no further direct testimony, we will now proceed to questions.

General, on pages 8 and 9, really on 9, the latter part of the sentence reads:

> The U.S. should proceed toward developing a meaningful allied role in SDI research, one consistent with our technical requirements, regulations and international obligations.

I am inclined to think when I take a bill to the floor with other members of this subcommittee next year that someone may well point to that phrase and cite there is one omission, that omission being the economic situation of this country, the deteriorating balance-of-payments relationship we have with a number of nations around the world.

My question is: Was the international economic situation or domestic economic situation and particularly the seriously eroding balance-of-payment situation between this Nation and other nations of the world taken into consideration at the time that you and others in the administration formulated a policy toward allied participation?

The question is directed to both witnesses.

Mr. Secretary, since it involves policy, you may want to lead on that.

Mr. **PERLE**. I do not believe, Mr. Chairman, that that issue was directly considered at that time, I think in part because we would just be beginning the process of involving our allies and it is unlikely to have, at least in the short term, significant impact on the balance of payments overall; perhaps also because with most of our allies, the bilateral trade in the defense sector is very much in favor of the United States.

They have consistently requested that we find more of a two-way street in defense trade. This is one area in which we might be able to achieve that objective to which we and previous administrations have been committed; to at least try to equal things up where we can.

Senator **WARNER**. Today before another committee this issue was raised and there was a specific amendment containing language that I will be provided with shortly, I hope, addressing this point and there seemed to be considerable support within that subcommittee.

The amendment was not adopted. However, the report language embracing the policy was. I will return to that specific point as soon as I am provided with the details.

Another amendment that is likely to be brought up would simply be reinforcing this policy decision if the Senate is inclined to adopt it, that you would be limited to issuing RFD's or contracts only for that measure of expertise or facilities that cannot be duplicated here in the United States.

Would either of you care to address that issue?

General ABRAHAMSON. We are well aware there is already on the record and in the books the Birch Bayh amendment of 1972 that applies to research outside of the United States and indicates that there must be a test in terms of the cost effectiveness of that research.

We clearly recognize that that is one of the U.S. procedures and regulations that we must be cognizant of and pay very close attention to.

Again, when we are looking to a capability that we may not need to duplicate or investment we may not need to make or facilitate that is available to us, that we may be able to exploit. I believe that we can see that there is the potential of a favorable economic trade for the program and that both our allies and ourselves come out stronger because we both participate in the SDI Program.

Mr. PERLE. Senator, I would very much hope that we would not add further restrictive legislation that would prevent the Department of Defense from awarding contracts where we think there are significant advantages to be gained, not only because it would impede cooperation with our allies and because it is the source of real concern with our allies, not simply because it is a protectionist measure at a time when we think our overall economic interests are best served by breaking down barriers to free trade rather than erecting them, but because we need as an alliance a far more integrated approach to advanced technological research and development.

There is tremendous duplication going on in this alliance already where one country after another reproduces work already done at enormous expense and it is depleting the defense budgets of all of us.

I would very much hope we would not get still more restrictive protectionist legislation and if we do, we should recognize that it imposes an additional cost on the defense budget.

Senator WARNER. Mr. Secretary, please do not interpret my questions as indicating this Senator's views. My views pretty much coincide with those policies of the Department of Defense and which recognize the value.

As I say, I anticipate in the debate that the point will be raised if it can be built in the United States, then we are simply contracting overseas to get the vote beyond the ocean, a vote in support of this program. We have to be prepared to wrestle with that argument.

Can you give any precedence for this sort of broad technical cooperation with allies on another program?

General **Abrahamson**. Yes. Sir, there are many precedents. I think the most common one and the one that people are most used to and one that I am certainly familiar with is in joint production programs. I would offer as a very concrete example the F-16 as a partnership program that the United States made the primary research investment in that particular airplane.

Then we entered into a partnership with four European nations and in the long run the large economic flow was certainly back to the United States. But at that same time it did modernize and improve not only the military forces, but also the defense and economic infrastructure of the four European nations.

So, as I would echo Secretary Perle's concerns, I would add that I think it is important that we take the long view of where we are as opposed to the short view.

Another example, only more in the research area, and again that I am familiar with, is in the space shuttle and space lab programs. There, the fact that we had a joint program with the European space agency meant that the U.S. taxpayers did not have to invest over $1 billion in the development of the space lab.

Nonetheless, that is a joint facility now available to all of us, including the SDI Program and I expect we may well use it for space research and in that case obviate the expenditures.

Senator **Warner**. Was consideration given to a policy by which all prime contractors would be United States and then an inducement for them to subcontract with our allies?

General **Abrahamson**. We examined that and we felt that that was overly restrictive, sir. I am sure that in many cases that will probably be a common form of cooperative effort. I know that European allied companies are going around and discussing with U.S. companies that they do business with quite normally and trying to convince them that they have special capabilities that they may add to our efforts.

I am sure there are specific times and specific technologies where it does make sense to go directly to an allied nation. Let me give you one example.

In one of the capabilities that is a potential that we might use is a very low cost spacecraft developed by MME in Germany. In order to have access to that spacecraft, it would not make sense to go to a U.S. contractor and then pay overhead charges just to have access and to use that. It makes better sense to go directly to the developer.

Senator **Warner**. You say it would be more cost effective?

General **Abrahamson**. Yes, sir, more cost effective.

Senator **Warner**. Of course, the program described by the President and others is to provide, and that is a point on which I have a departure with my respected President, the shield concept over the United States, the umbrella shield, however it is referred to.

Nevertheless, there is going to be substantial knowledge gained during the course of this program that would provide a defense for our allies against their potential threats, be they intermediate or indeed some ballistic missile systems.

Have you tried to prioritize between intercontinental ballistic systems and what ancillary fallout may come with respect to protection of our allies? Was that a factor in this equation?

Mr. PERLE. Mr. Chairman, maybe I can take a crack at this.

Senator WARNER. Yes. You gentleman decide among yourselves who should initiate the answer.

Mr. PERLE. General Abrahamson undoubtedly has some thoughts on this, sir.

Let me say first that I think it is quite wrong to distinguish between the kind of strategic defense that would protect targets in the United States and the kind of strategic defense that would protect targets in Europe and elsewhere.

This is true because, in my judgment, the most promising element of the Strategic Defense-Research Program entails intercepting Soviet missiles in the boost phase before there is a discernible target, at a point at which the target could be anywhere within the range of those missiles, including Europe or the United States or our friends in the Pacific or elsewhere.

The image of the shield or dome over the United States, is, I think, one of the reasons why some of our European allies, in particular, were skeptical at the outset.

If we are successful in developing the boost phase intercept capability, we will be putting the dome not over the United States, but over the Soviet Union. It is the inside of that dome that the Soviet missiles will be unable to penetrate.

That image, which I believe is the correct one, makes the whole program look very different from the European point of view. If you are bottling up those missiles over Soviet territory, then whether you live in Europe or Japan or Washington, DC, you are protected against those offensive Soviet missiles.

Now, the SDI Program is aimed at principally ballistic missiles that have a relatively long burn time in the boost phase and that travel intercontinental trajectories or if not intercontinental trajectories, rather close to it, like the trajectory of the SS-20 which has a range of the order of 5,000 kilometers.

If we are successful, SDI will produce an effective defense against missiles of that type. This leaves shorter range missiles that have much shallower trajectories, much shorter burn times and against which the bulk of our SDI effort would not yield an effective defense, although much of the technology developed could be applicable to defense against those shorter range missiles.

There is a lot of talk in Europe now about European interest in a European Defense Initiative and we have observed that a discussion in Germany, in the United Kingdom, even in France and Italy, with some considerable interest because it would obviously make sense for the Europeans who are making a sizable investment in the defense of their territory against Soviet aircraft not to leave themselves vulnerable to attack by missiles aimed at precisely the same targets that the air defenses are intended to protect.

If our European allies were to approach us to indicate an interest in working together on a defense against tactical ballistic missiles, that is something I think would be of very considerable interest to us.

It does seem to me that they ought to take the lead for a number of reasons, the most important of which is not technical, but political. In my view, it would launch a program aimed at defense against shorter range ballistic missiles far more effectively if it were not thought to be yet another American weapon system to be placed in Europe, but if it were a European proposal on which we were able to cooperate.

So, I am hopeful that the Europeans who have expressed interest will find a way to get together and cooperate with the United States on a European Defense Initiative that will be initiated by them and in which we would be, I think, very interested in cooperating.

Senator WARNER. Thank you, Mr. Secretary.

General, do you have anything to add to that.

General ABRAHAMSON. Sir, I would like to bring up one of the very important issues that Secretary Perle identified and that is that the technology in some cases is applied differently against the very short-range threat.

In some cases it is exactly the same technology and there are some very, very close relationships between the research that we are undertaking now and a proper layered defense that would protect not only allies or European targets or Pacific allied targets, but also U.S. forces stationed overseas in the same way.

Perhaps a simple way to explain one of these is a concept that a U.S. company working with an overseas company has brought to me, and I will show it very briefly. It can give you an example of the kind of technology.

You know that I have talked to this committee several times about our work on rail guns and how space-borne rail guns may be a very effective kind of system for the defense, for boost phase intercept. This is a concept for a ground-based rail gun installation that might be considerably cheaper, less expensive and a series of small missiles that will be able to fire at very high speed.

What you see here is an underground installation with the rail gun pointing up and the key in some of the technologies is primarily that you would use a different kind of interceptor because you would not be going at the high speed we would go in space.

Where we would want to go 20 or 30 kilometers per second in space, we might only need to go between 5 and 7 kilometers on the Earth. Here are some of the calculations that show that you can indeed reach ranges using these kinds of technologies out to between 250 and 300 kilometers.

It is one example of a kind of application of the work that we are presently doing to the work that might be required for the shorter-range missiles as well as some of the SS-20 types and intermediate range.

Senator WARNER. Thank you.

That concludes my time. I will now defer to my colleague, Senator Thurmond.

Senator THURMOND. Thank you very much, Mr. Chairman.

I want to commend you for the splendid work you are doing in this field. General Abrahamson has performed nobly in the work he is doing which I think is most important to our Nation.

I am very glad to have Mr. Perle here who has taken a very strong stand which all Americans, I am sure, appreciate. I do not have any particular questions at this time. I appreciate your being here.

Mr. PERLE. I thank you, sir.

General **Abrahamson**. Thank you, sir.

Senator **Warner**. Senator Quayle.

Senator **Quayle**. Thank you, Mr. Chairman.

I would like to pick up on the ABM question. First of all, I want to congratulate you on your statements concerning ABM on pages 5 and 6. One of the sentences says:

> The question of conventional deterrence is not in the forefront.

Do you think it should be? You do not say it should be. You just say it is not.

> Too often in the debate surrounding the SDI, the question of conventional deterrence is not in the forefront.

Particularly in relationship to NATO and looking at the new threat of the conventional and chemical capabilities of the SS–21's, 22's, and 23's short-range ballistic missiles, should this threat not be in the forefront of the SDI discussion, particularly in this area as we discuss our application in NATO?

General **Abrahamson**. Sir, I agree that it should be. I think that deterrence is something that has to be at all levels of the spectrum starting with the national resolve, acting certainly through our conventional forces all the way up through the nuclear levels.

Unfortunately, it has not been particularly emphasized the way one would like. I am not an agent in this case, but I will point out I think that out of our discussions in Europe and with our other allies we are indeed beginning to bring out these relationships between defense and improved deterrence.

Here I have a book, unfortunately published in French by Gen. Pierre Gallois, the father of the French nuclear deterrent, where he does go into great detail about some of the strategic and tactical relationships for defense and how that contributes to both conventional deterrence and the control of escalation up to the nuclear level. It is a very interesting book.

Senator **Quayle**. I would like to explore as much as I can where we are with potential development of ABM. Have we done a study to look at architectural designs of potential ABM's? I am under the particular impression from Mr. Perle's response to Senator Warner that it should be a European initiative, and I agree with that, but it seems that we are going to still be involved on the ground floor on architectural design, of pointing out what is doable and what is not doable.

I guess I would like to get a dialog, since we have the two of you today, to lay our groundwork on future things with ATBM.

Where are we? What are we specifically doing to advance a potential ATBM employment in Europe which is within the confines of the ABM Treaty?

General **Abrahamson**. Your statement is conventional deterrence, particularly against these ballistic missiles, conventional and chemical capability has not been addressed in the past, it has not been in the forefront, but it should be.

What are we doing? Do we have architectural studies focused on these theater range ballistic missiles, SS–21's, 22's, and 23's?

Mr. Perle may want to go first. I really want to lay this agenda out. I for one will continue to push in this area. I will be quite honest. I have had a good response, favorable, but it is not terribly definite. I would like to get some specifics if I can.

General **Abrahamson**. First, let me respond programmatically and Secretary Perle would like to add strategic policy considerations to the broad discussion.

To answer your question directly, in our architectural study we started and completed phase one with 10 different contractors. We did include the requirement to examine how the technologies and how the architectures might apply against the shorter range threats that are of concern to our allies, both in the Pacific theaters and in the European theaters.

Senator **Quayle**. When you talk about shorter range threat, are your talking about the SS–21's, 22's, and 23's?

General **Abrahamson**. Yes, sir. They have other shorter range missiles, but I am looking at the SS–21's, 22's and 23's.

In the closed portion of the hearing I can respond more directly and I can show you the examples of some of the conclusions of some of those architectural study efforts and some of the ones that I showed to the military committee on Monday, by the way, because there is a great deal of interest, as Secretary Perle indicated, about not only the technology and how it applies to short-range missile threats, but also can they be more broadly applied in all of the conventional areas that we are worrying about and are concerned with for our mutual security.

The answer is yes, we have looked at them. I will have to say that we are, I think, not as far ahead in some of the specific applications of all of the technologies to those shorter range problems as we are in some of the longer range problems. But, as I indicated, there is an overlap, a very definite overlap.

Many of the technologies overlap. We have just begun to examine how closely and how carefully they can tie together in order to be able to create a layered effective defense against the shorter range threats such as the SS–21's, 22's, 23's and the 20's.

Senator **Quayle**. I certainly understand that there is overlap. My interest is on this narrow point, specifically on the short-range ballistic missile, specifically as they would apply to you, because I am of the opinion as we go forward that that is probably going to be the first application of SDI technology.

Am I off on this road that we are going to be traveling as we look at the overall strategic defense initiative?

First of all, you can do ATBM under the ABM Treaty? Am I thinking improperly?

General **Abrahamson**. I do not think you are thinking improperly at all, sir. I will recall for you the direction from the President is, and our testimony that we have made in many forms is that we are to examine the problem of defense against ballistic missiles of all ranges for the United States and our allies.

As I indicated, in some areas we are not quite as far along. In the closed portion of the session I think I can give you a better and more direct answer.

Senator **Quayle**. Have we done a separate study just on the short-range threat? Is that yes or no?

General **Abrahamson**. There have been within other portions of the Defense Department many separate studies on which we could build and to which we could refer. But within the SDI Program office and within our architectural studies we have looked at how the SDI technologies can enhance and can supplement those kinds of systems and be applied in order to achieve this very much more robust defense.

So, there have been studies like that, but those are different studies from the ones we are presently doing and have done in our architectural study.

Senator **Quayle**. Certainly it would make sense to me, Mr. Chairman, that we ought to look at this issue separately, look at a separate study on the short range.

I would like Mr. Perle to comment.

Senator **Warner**. Mr. Perle.

Mr. **Perle**. Only to this effect, Senator. I think the deployment of the defense against the SS-21's, 22's and 23's would, in a sense, be a logical extension of efforts that our allies are already making to deal with the threat against air-delivered weapons because the targets are very much the same targets.

They are critical allied defense installations, the airfields from which tactical fighters and fighters with ground support will be based, nuclear installations and the like.

So, in my judgment, there is no philosophical obstacle to the notion it is a good idea to defend critical installations in Europe. I think that view is held by most of our allies. There are obvious budgetary concerns at a time of constrained budgets when modernized air defenses are only now coming into the inventories of a number of our European allies.

I think they would be greatly encouraged by the prospect of a trans-Atlantic program that would entail real cost sharing so that the burden is borne not only by those countries who live in the most immediate shadow of those short-range Soviet missiles, all of which are mobile or would move to the front so they pose a threat not only to the initial peacetime locations, but also in the course of a conventional war it would pose a threat as the front moves forward to virtually all the continental countries of the alliance.

It seems to us a very good idea in principle. It seems to us an idea that could most fruitfully be pursued on an inter-allied basis, on a cooperative basis. I think the momentum is gathering on the European side and, in my own view, we will see shortly enough of an expression of interest from our allies so that it would make sense to begin to talk about whether a cooperative program could be put together.

We had the sense that it is wise to permit our allies to take the initiative here because their commitment to the program and the ultimate success of the program would be greatly enhanced if they were to take the lead.

In the meantime, as General Abrahamson observes, as we go about work on the SDI Program, generally we are developing technologies, including data handling, data transmission and tracking and sensing technologies, that will turn out to be applicable to the defense against short-range missiles as well.

Senator **Quayle**. Thank you.

Senator **Warner**. Senator Exon.

Senator **Exon**. Thank you.

I am glad to welcome you again. I am pleased to have public sessions on this subject in addition to the classified briefings given to us from time to time in closed session. I do not intend at this time to get into anything that would be best discussed in closed session.

General Abrahamson, as you know, I have been a supporter of ballistic missile defense research and development even before the establishment of the SDI Program. I think it is very important, though, that the American people have a clear understanding of what we are trying to do with SDI.

I compliment you for what I think is basically a good job. Somewhere along the line, though, I think it might be appropriate that we try to level with the American people so that they do not anticipate more than is possible or expect too much from the program too soon.

In your opinion, is there any possibility that we would ever be able to have a total shield over the United States of America such as that frequently depicted on television. Is it possible to have a system that would have all the incoming Soviet missiles bounce off a shield so that we would have nothing to worry about hereafter?

Do you think that this sales approach is overdone a little bit?

General Abrahamson. Senator, I would like to start by thanking you for your support. It has been consistent and strong and we appreciate it.

I have testified many times and explained that I do not believe that there is any such thing as a perfect weapon. However, our objective is to conduct the research so that the Nation can have the option of building a very effective layered defense and in that case I really wish to underscore and stress the layered aspect of it.

Therefore, I think that that image is an oversimplified image. In that sense, it is a difficult one. It is the layered defense that makes the targeting problem so difficult for the other side that really builds in the deterrent quality of a strategic defense should it be initiated at some time and be built in the future.

It is that layered quality that if we can find a truly cost-effective means of erecting those many barriers, can lead us to an option that could be what we have called thoroughly reliable, and what we mean by that is something that would be a very, very effective defense.

Obviously, a defense is perfect if it is so good that the other side decides they cannot achieve their military objective and, therefore, they do not attack and we achieve deterrence. But I do not believe there is such a thing as a perfect weapon ever.

Senator Exon. General, I compliment you for being forthright on that. I just wish we could get across a more accurate portrayal of SDI, one in which it is not a cure-all.

How do you feel about that, Secretary Perle?

Mr. Perle. I think it is important to distinguish between what we think can be accomplished in the relatively near term and what it may prove possible to accomplish in the long term, recognizing that there is an offense-defense relationship today as there was in the relationship between the crossbow and the hand-carried shields that were erected against them.

In the short term if we are successful and in particular if we are successful in developing systems for boost phase intercept, I think we can make a major important contribution to the stability of the strategic relationship, to the stability of deterrence, by putting in place a defense that would render ineffective any plans the Soviets might conceive to launch a first strike against the strategic retaliatory forces of the United States.

So, a partially effective shield, if you wish to view it that way, could be a totally effective device for strengthening deterrence and restoring stability and the balance between ourselves and the Soviets.

So, in a strategic sense it would be far more effective than the less than perfect intercept rates might suggest. In that sense, I think a great deal can be accomplished with a partially effective defense.

Over the longer term, the second generation or third generation systems, a system that entails many layers, it may be possible to achieve very high intercept rates that would reduce to a very small fraction the number of weapons that could be delivered against the United States.

Senator **Exon**. Mr. Secretary, let me ask you this question. I guess what I keep harping on is, that we should be honest and forthright with the American people.

Do you agree with the SDI system of some television commercials which tend, I believe, to mislead the people to believe that an impenetrable shield can be developed so that the little girl in the cartoon can live merrily and happily on?

Are these commercials personally offensive to you or do you think that they are pretty good stuff?

Mr. **Perle**. Frankly, I prefer to see the discussion of an issue as complex as this carried on at a level where the complexities can be explored, and rainbows that constitute a shield against ballistic missiles does not add much to the overall debate.

I do think, and I feel bound to say, that there are simplifications of another kind as well, the notion that every man, woman, and child will be destroyed in a nuclear war, that, therefore, we need not worry about the size of the Soviet arsenal or our own capacity to survive an attack, and so on.

I think we would be better off on all sides if we did not resort to these images that are powerful emotional images, but do not enlighten us.

Senator **Exon**. Is it fair to say that both of you agree that some of the recent pro-SDI television commercials may at least, to some degree, overstate the SDI Program and what it is likely to be realistically attained as far as strategic defense is concerned?

General **Abrahamson**. I should like to add, Senator, that I think in order to be fair in the statement and in the concern that you just laid out, that the first television advertisements were more than equally misleading by several of our critics where they showed again this little girl being destroyed by a laser beam from space, which is absolutely not the intent nor, frankly, I think within the capability of the kind of weapons we are developing.

So, I think that there has been some very offensive and misleading and simplified advertising on the other side as well.

Senator **Exon**. Maybe I do not watch television as much as others but I have not seen those that you spoke of.

General **Abrahamson**. Those were quite some time ago, sir.

Senator **Exon**. I have seen several on "Nightline" that I thought were pretty misleading.

If my time is not up, Mr. Chairman, may I add one question?

What can you say, either one or both of you, now as to classifying what keeps coming up, and that is during our research on SDI, which is aimed, of course, at a defensive program and defensive posture, are there not likely to be some accruing benefits as far as offensive weapons are concerned as we go forward with this research?

Mr. **Perle**. I think if your desire was to improve offensive weapons, we would do so with far greater effectiveness and at much lower cost to allocate research funds for that purpose and not hope to derive some secondary or tertiary technological benefits or spinoffs from the SDI Program.

I know the Soviets make the charge that there is an offensive side to the SDI Program that envisions attacking targets on Earth from platforms in space. I rather hope that their concerns about that is one of the principal reasons why they have been unwilling even to talk about the transition for defenses because I think we can disabuse them on that.

We have no such plans, we have no such programs. SDI is aimed, as we have said from the beginning, at a defense against ballistic missles and not at projecting offensive capability.

Senator **Exon**. Thank you, Mr. Secretary.

General, what byproducts of our SDI research can we expect? Is it not likely that they could be significant? Could they not open new avenues of research?

General **Abrahamson**. Sir, the majority of the kinds of things that we are doing, and let us restrict it to weapons at this point, if they are going to be very effective for their mission, and this is the point that I think Secretary Perle is making, they are researched in a particular direction. Let me give you some examples.

A neutral particle beam—and I have shown pictures of a neutral particle beam to this committee in another forum—again, it may be a very effective weapon against other weapons in the very, very high reaches of the atmosphere in space, but it cannot penetrate the atmosphere.

I talked about rail guns, firing them at 20 to 30 kilometers per second. So long as we are interested in firing them at those kinds of speeds, we will have a great deal of difficulty having them survive their reentry to the Earth.

In these cases we are talking about weapons that have no warheads at all. There is a series of those kinds of things that just belie that overall concern.

Senator **Exon**. Thank you.

Senator **Warner**. Thank you very much.

I have a few minutes in my time and before Secretary Perle leaves, perhaps Senator Levin might have questions.

Listening to your testimony as justification for SDI, you said it would render a first strike far less effective and you again use the phrase "restoring stability" between the two nations.

Quickly, General, if we went full power, what is the earliest possible date we could have an element, even though it is partial, of a SDI defense in place?

General ABRAHAMSON. Obviously, it depends partially on the success of the research, but I would say in the early 1990's. Somewhere in the first half of the 1990's.

Senator WARNER. Secretary Weinberger said today that we are making tremendous progress, far more than they had excepted.

General ABRAHAMSON. That is a true statement.

Senator WARNER. If we were to introduce some element of SDI in the early 1990's, that is when the restoration of stability you are addressing would take place. I raise the question in the Strategic Modernization Program that President Reagan initiated, and quite properly, with the B-1, the D-5, MX, certain portions of MX, cruise missiles and the like.

Do you anticipate an unstable strategic relationship in the early 1990's, Secretary Perle, that needs to be corrected by SDI?

Mr. PERLE. I think it is hard to say what we will encounter in the 1990's because a great deal depends on what the Soviets do between now and then. I believe, Senator, that when we pass from a more tranquil and stable period in which it is not possible to attack retaliatory forces on the other side rapidly because we lack on both sides weapons with the accuracies and yields and the numbers of them to accomplish that task, the balance becomes a good deal more stable.

It will remain, in my view, relatively unstable, not to say dangerously unstable, until we get to a situation in which that capacity, capacity offensively to attack and greatly diminish the ability to respond is handled somehow, and, in my view, the best way to handle it is by having defensive weapons rather than offensive weapons in order to maintain, an adequate enough survivable retaliatory capability.

It seems to me that you can deal with the growing Soviet offense in two ways. Either by increasing our own offensive capability and working hard to make our forces more secure than we are doing or by introducing defenses.

The Soviets have lots of advantages when it comes to the proliferation of offensive forces. We are at a disadvantage in that area. But I think we have potential advantages when it comes to deployment of defenses.

So, it seems to me that we are wise to play to our own strengths and not to compete where we are weaker.

Senator WARNER. We repeatedly hear the term of limited SDI deployment being an option.

Is it possible to quantify this SDI system, the proposed umbrella, layered defense, in such a way that it meets the definition of a limited SDI deployment from a technical standpoint?

General ABRAHAMSON. I am not sure that there is a single definition of what a limited deployment might be. I think there is probably a series of them, sir.

Senator WARNER. We are having a limited deployment now of MX.

General ABRAHAMSON. Yes, sir.

Senator **Warner**. We are having a limited deployment of the B-1; namely, we have capped it at 100.

General **Abrahamson**. Right.

Senator **Warner**. Is there any quantified means of capping SDI as we try to work on arms control and elsewhere in this equation of stability?

General **Abrahamson**. I think the important characteristic of any new concept such as SDI as a system or systems is that it would not be introduced all at once. It will be introduced gradually.

So, rather than a single cutoff point or a single point that you define limited as being 30 percent effective or 40 or 50, actually it is the choice of the policy and strategic people, the way they care to describe it.

Senator **Warner**. So, we could deploy a SDI system, which from a technical standpoint could be verified as having the capability of only interdicting, say, 30 percent of the incoming Soviet ICBM's, assuming it worked, as your goal?

General **Abrahamson**. Yes, sir.

Senator **Warner**. In that sense, it would be limited?

General **Abrahamson**. Yes, sir; that is possible.

Senator **Warner**. My last question to Mr. Perle.

What would be your view on a possible amendment that sought to tie the administration to a restrictive interpretation of the ABM Treaty as we proceed with the SDI Program?

Mr. **Perle**. I would be very much opposed to that for a number of reasons.

For one, I believe that the restrictive interpretation is not the legally correct interpretation.

Senator **Warner**. That is your view and the President has taken for policy purposes a contrary one; is that not correct?

Mr. **Perle**. No. The President has taken the view that a less restrictive interpretation is legally justified. He went on to say that because our current program is configured with the restrictive interpretation in mind, the issue is moot and our current program is consistent with the restrictive interpretation.

I think to seek to impose restrictions greater than those entailed in the treaty itself and to do so by statutory amendment, among other things, has important constitutional consequences.

Treaties require a two-thirds vote and a simple statute would not. I should think the Senate would want to think twice before seeking in effect to amend the treaty by statute.

But beyond that we have made it very clear, I believe, that the treaty permits development, research, and testing of systems based on other physical principles. The Soviets are free to conduct such development, research, and testing.

An amendment that prevented the United States from doing so would be unilateral in effect and would place us at a significant unilateral disadvantage. Frankly, the ABM Treaty is a treaty that the Soviets are now violating.

Senator **Warner**. Of that we are aware.

The last point is: Could this President or future Presidents by simply the flick of a pen direct the administration to depart from the present posture and go to a broader, less restrictive posture and doesn't that potential of the President having that power lend to the instability of the relationship?

Mr. PERLE. Not at all.

First of all, nothing is established by the flick of a pen. What the President could do is propose to the Congress that you give us the funds necessary to carry out the experiments that would be permitted under the broader interpretation and prohibited under the narrower interpretation.

The Congress' wisdom would accept or reject those programs. So, there is congressional control over what we actually do. If you restrict the program to the restrictive interpretation, it would so prejudice the prospect for success that it would become questionable, in my view, whether we should continue with the program at all.

Senator WARNER. You recognize my questions are not suggestive of my views?

Mr. PERLE. I do.

Senator WARNER. Senator Nunn.

Senator NUNN. General Abrahamson, do you agree with the last statement Mr. Perle made that if we did adhere to the strict interpretation—I suppose you mean by that not just in the short term, but over a longer period of time—that we cannot carry out the necessary program of research and, therefore, we might as well drop the program?

General ABRAHAMSON. I probably would say it slightly different, but I will put it this way.

In the long run we will bring forward a body of information, of tests, some of which will be very complex, some of which will all be partial tests under the restrictive interpretation of the treaty.

And all of us, not just the Congress of the United States and our allies as well, but I can assure you those of us over in the Pentagon, even some who are very used to dealing with these technical decisions, are going to have to be able to integrate what the meanings of all these tests are in a very difficult way.

That may require more dollars and more time to be able to show to all of the decisionmakers that we really have achieved the three very important essential criteria that I have talked about many times, of technical workability, of not being able to have simple countermeasure, and having it be affordable.

At some time, sir, I believe that clearly to go into the development stage, we will have to modify the treaty and we have said that. At some time I believe that it may be cheaper and less expensive to be able to move to the less restrictive version of the treaty. But we are not at that point now.

Senator NUNN. When do you think we will cross the threshold between the narrow interpretation of the treaty, which the President has decided to adhere to, and the broader interpretation?

I assume you are saying if we had the broader interpretation, they would proceed without amending the ABM Treaty or under either, would we have to amend the ABM Treaty?

General ABRAHAMSON. To go to a deployed system under either, we would have to amend the treaty.

Senator NUNN. How about going into the development? Would we have to amend the ABM Treaty?

General ABRAHAMSON. I believe the interpretation agreed upon by various legal counsels, both at State and the Department of Defense, is that for those systems that are based on other physical principles, and that means other than the traditional kind of interceptors and radar, meaning the lasers or those kinds of systems, that we could proceed into the development phase with the broader interpretation of the treaty, but I think that is several years away.

Senator NUNN. When do you think that will be, because as I hear what you are saying, it is that under either the broad or narrow interpretation of the ABM Treaty, to deploy, we would have to amend the treaty?

General ABRAHAMSON. Yes, sir.

Senator NUNN. Or abrogate the treaty, one or the other.

The second thing I hear you saying is that under the broader interpretation of the treaty we could move on through the development stage short of deployment, but we could not do that under the narrow interpretation.

Is that what you are saying?

General ABRAHAMSON. Yes, sir; I only say that in the context of these systems that are of other physical principles.

Senator NUNN. When do we arrive at that date?

We have to make a decision. We have to make a decision between a narrow and broader interpretation of the treaty in terms of proceeding with development.

General ABRAHAMSON. I have not calculated that kind of number. My direction is very clear from the President and that is that we laid out the program initially narrowly and then based on the direction, to maintain that narrow interpretation.

Senator NUNN. How long can you continue with the narrow interpretation and still do the necessary work?

General ABRAHAMSON. We have planned to proceed into the early 1990 timeframe. As I tried to indicate, what will come will be a very difficult decision, a very complex decision.

Senator NUNN. You are saying up until——

General ABRAHAMSON. That is why I am saying it is several years away.

Senator NUNN. You are saying up until the early 1990's we can continue to adhere to the narrow interpretation of the treaty without disrupting your planned program?

General ABRAHAMSON. There may be additional costs and we may be able to go more directly and more quickly if we have that other interpretation.

Senator NUNN. It will not disrupt the program, but it might delay it?

General ABRAHAMSON. And it would cost more.

Senator NUNN. When will you reach the stage that it will be delayed or cost more, sticking to the narrow interpretation?

General ABRAHAMSON. Sir; it would be a guess if I gave you an answer.

Senator NUNN. Would it be in the eighties or in the nineties?

General ABRAHAMSON. Well, it would be several years away.

Senator NUNN. We are several years away from that?

General ABRAHAMSON. Yes.

Mr. PERLE. Could I continue on that, Senator?

Senator **Nunn**. If I could ask another line of questions. We can come back to this I want to pursue this other line which is totally different from that one.

I want to ask you, Mr. Perle, this. On the NATO strategy now, General Abrahamson on page 3 of his statement says, and I quote:

> We and our allies developed the strategy of flexibile response—the cornerstone of U.S. and allied security for almost 20 years. We in no way seek to discard this strategy, but rather look forward for strenghening its very flexibility.

Looking at the NATO strategy regarding this and SDI, would I be correct, Mr. Perle in defining the NATO strategy the so-called flexible reponse strategy, as:

First, defended conventionally forward.

Second, if conventional defense fails, NATO escalates with nuclear weapons.

Third, if limited theater nuclear use does not lead to termination, the United States will use strategic nuclear forces.

Is that your general understanding of flexible response?

Mr. **Perle**. I do not know that I would put it exactly that way, but that is close enough for the purpose of the discussion.

Senator **Nunn**. General Abrahamson, let us assume here that we project forward to the future and we have a fully effective SDI. That is assumption No. 1.

Second, in consonance with the President's pledge, we have given away or sold the SDI facilities so that they have one also. That is a second assumption.

Third, both sides also have highly effective defenses against deep penetration by aircraft and cruise missiles, since we all know that would also have to be an additional element to protect ourselves against nuclear attack.

With those three assumptions, what would the flexible response do at that stage?

Both of us have effective defenses. Both of us have defenses against aircraft and cruise missiles. Presumably, the Soviets still have somewhere in the neighborhood of 48,000 tanks.

How does NATO implement the second and third tiers of flexible response?

That is to say, a Soviet conventional attack. General Rogers said right now we can defend for only days, not weeks, and we would have to turn to nuclear weapons.

How do you turn to nuclear weapons if you have both sides with a fully effective SDI?

General **Abrahamson**. Sir, first of all, that is a very, very hypothetical question. You are asking me to go a long way into an area in the future that I have not in fact developed that fully.

Senator **Nunn**. Despite what the President has outlined as a goal?

General **Abrahamson**. Prior to your arrival here today, I did recommend to the subcommittee and provided copies of the relationship between offense and defense, a very thoughtful paper, by Gen. William Odom that I think goes a step, it does not go all the way, to answer your question, but it goes a step in the direction of showing how a defense can contribute even in a transition period and in the long term.

I also recommended a very interesting book, if you can read French, by Gen. Pierre Gallois, about the relationship of a defense, particularly a conventional defense, at a point in time where they may strike, not only with nuclear weapons, but also with conventional warheads and strike accurately.

Senator NUNN. You have gotten far away from my scenario. It is interesting, but irrelevant to my question.

The President has laid out a vision. I have just given you the basic assumptions of his vision.

Mr. PERLE. No; you have not. You have leaped 20 years forward in one area and left the world unchanged in another. I do not think we face 48,000 tanks 20 years hence; we will probably face 100 tanks.

Senator NUNN. You pick your assumption on what kind of conventional balance we are going to have.

Mr. PERLE. I do not think you can very usefully answer these questions, in the abstract, what kind of strategic forces the Soviets have then, what sort do we have, what is their relative survivability, what is the situation in Europe?

It is awfully difficult to project forward 20 years without projecting everything forward. I do not think you can do that very usefully.

Senator NUNN. Isn't that what the President has done when he says this is our goal in SDI and we are going to basically turn this over to the Soviets and we are going to eliminate nuclear weapons?

Mr. PERLE. I do not think it is nearly as simple as that. I think it is a caricature of what the President said.

Senator NUNN. We can get the exact quote. That is my understanding of his vision.

Mr. PERLE. When the President talks about a dream of a fully effective SDI and talks about sharing with the Soviet Union, he has in mind a world in which a number of events have taken place in the intervening years, one of which is very significant disarmament of offensive intercontinental weapons.

That is a very different situation from one in which you have massive offensive arsenals on both sides as we do today. I do not believe the President is talking about sharing a completed SDI system with the Soviet Union in possession of tens of thousands of offensive weapons aimed at the United States.

Senator NUNN. Will you tell us about the open lab proposal, what that means, which I understand is on the table at Geneva now?

Mr. PERLE. Yes; I am glad to try to clarify that.

It does not mean that we are inviting Soviet scientists to come and work in our laboratories. It means that given the Soviet refusal to acknowledge that they even have a strategic defense program of their own underway and given their evident curiosity about our program, it might help to build confidence on both sides if we saw enough of what each of us was doing to feel we have a better sense of where each side is headed.

We are attempting to negotiate with a negotiating partner who says he has no program. We know that that is not so. We are prepared to invite the Soviets to pay controlled visits to our laboratories and we would like the opportunity to do the same because we think we can negotiate more effectively with some candor between us about what each of us is doing.

We have been quite willing to tell the Soviets in broad terms what we are doing. General Abrahamson is prepared to brief the Soviets on what we are doing, but we continue to face an interlocutor who says, the Soviet Union has no SDI and we know that is not the case.

It is not an invitation to transfer tomorrow the progress we have made in defensive technology, certainly not in a world in which the Soviets go on building offensive weapons. It is wrong to take this long-term vision and attempt to apply it to current world circumstances.

Senator NUNN. That is precisely what I understand is being done with the SDI Program. That is what the people of the country understand the SDI to be.

If you think this kind of rhetorical oversimplification is not appropriate to the discussion of what we are really doing, then you and I are in complete agreement.

Mr. PERLE. I am saying that a long-term vision should be properly understood to be precisely that, long-term vision. You cannot apply a result we may not be able to achieve to a world in which the other quantities are known and rather menacing.

Senator NUNN. I have a long line of questions and we had better tone down our rhetoric.

I hear so much about the immorality of deterrence and immorality of striking back. The immorality of all of that I have seen in both the President's remarks and the Secretary of Defense's remarks and other remarks by the administration. If we are 20, 25, 30 years away from beginning to do away with retaliatory weapons, it seems to me that is a real danger.

Mr. PERLE. That is not what they are saying. They are not saying that offensive-dominant deterrence is immoral. The President has not said that nor has the Secretary of Defense.

I ask you whether offensive-dominant deterrence would be moral if we had a safer alternative which we do not now have?

Senator NUNN. I do not think any war at all with nuclear weapons in the broad context can be considered moral, but I think a threat to retaliate, to keep a war from happening at all, which is what we do now, is indeed moral because that is our alternative.

Based on what you and General Abrahamson have said, contrary to what the President and Secretary of Defense and others in the administration have implied, we are going to be relying on that deterrence and that threat to retaliate for many, many years to come.

So, it seems to me that the advice about not taking a distant vision and making it applicable to present circumstances should start in the executive branch and if it does, I think we will all be on a much better, more sound course of discussion.

My time has expired. I do not want to take any more time.

Mr. PERLE. Can I take some time.

Senator NUNN. I will defer to Senator Exon and Senator Levin, whoever is next.

Senator QUAYLE [presiding]. If you want to respond to that briefly, go ahead and respond and then we will call on Senator Levin.

Mr. PERLE. I want to say we have tried to approach this issue in a far more discriminating way. The characterizations of what the administration has said are not advancing the goal. It is a long-term goal. The utility of offensive-dominant deterrence has not been questioned by Secretary Weinberger or by the President.

We have a strategic modernization program aimed at maintaining deterrence and deterrence is our policy. It is our policy and will continue to be our policy for the foreseeable future.

Senator NUNN. I agree with that completely. I am glad you have clarified that. I can get us some quotes and I will while we are here. I will show you what else has been said in this regard if you have not seen it.

Mr. PERLE. There may be in the long-term future alternatives to deterrence as we know it today. I do not know anyone who believes that the world would not be better off if we could find a way to protect our security, security of our friends and allies, that did not entail the threat to destroy millions of people with nuclear weapons. That is a long-term vision.

It seems to me it is a worthy long-term vision, but we are not there yet and we have not made the mistake of believing that that long-term vision is today's reality. I hope others will not accuse us of making that misstatement.

Senator NUNN. I am still old fashioned enough to go by what people say.

Mr. PERLE. It is a matter of interpreting what people say. We talk about full employment and that is a long-term goal. We have never reached it and we probably will never reach it, but it is still worthwhile talking about it in setting objectives.

I can give you a long list of worthwhile public objectives that are stated in the long term because it is fundamental to the ordering of society that you think in terms of perfection or of a shield.

Senator NUNN. I have no objection to that. I have no objection to the way you characterize it. I think you and I are in agreement.

I think it is very important for leaders of this Nation in their prepared remarks also to describe it in these general terms so that the public or the country does not misinterpret it so that we do not get cheap TV ads on both sides that are confusing the American public and so, generally speaking, the American people can understand what our goals are so that we can have some kind of unity in this program.

I am suggesting to you that is not what has been said in the past. I have a memorandum here that has one and a half pages of these quotes precisely about immorality of the deterrence which I will be glad to share with you, but not at this point because I think it is Senator Levin's turn to ask questions.

Senator LEVIN. I would like to ask Secretary Perle a followup question to Senator Nunn's about the usefulness of SDI, given a stricter interpretation.

As I understand the position of both you and General Abrahamson, a restrictive interpretation at some point may cost us some money, may delay reaching conclusions on feasibility.

Would you agree that SDI is a useful program even if we permanently adopt a restrictive interpretation?

If that is what the President decided right now, would you disagree that we ought to proceed anyway with SDI?

Mr. PERLE. There is nothing permanent about a temporary decision.

Senator LEVIN. If that were the decision, a strict interpretation was the correct one, we would continue to follow it?

If it is the interpretation that has always been followed and we are going to continue it and we are no longer going to consider a broader interpretation, would you agree SDI would still be a useful program under those circumstances?

Mr. PERLE. I think the utility of it would lie in continuing work in the hope that at some point in the future we would not be bound by the restrictive interpretation.

Senator LEVIN. If you knew you could not avoid the restrictive interpretation, as a matter of fact, if we had a new negotiation with the Soviets and everybody agreed in that negotiation that was a correct interpretation, would you recommend we drop SDI or discontinue it?

Mr. PERLE. The reason why I do not want to answer the hypothetical is that the situation is not a real situation.

Senator LEVIN. That is what hypothetical questions are for. All I have done is define a hypothetical question.

Mr. PERLE. Hypothetical questions are to ensnare the witness in a statement——

Senator LEVIN. I am trying to get an opinion whether SDI was a useful program at its beginning when that was an assumption that it was a narrow construction.

Was it useful then or not?

Mr. PERLE. A lot depends on the basis upon which an executive or a Congress would make the decision to go forward with an SDI on the basis of experimentation.

Senator LEVIN. Let me ask you another question. I would like to clear the air with both of you on this in terms of discussion inside the Defense Department, the military establishment, about the advantage of spreading SDI dollars around to allies in order to build up a political consensus.

Have there been any discussions in which either of you advocated or the Secretary or Secretary Taft advocated SDI dollars being sent over to the Europeans and their allies in order to build a consensus for SDI among those allies?

Have either of you heard such argument or participated in any discussions in which that argument was made?

Mr. PERLE. I have not heard that argument.

General ABRAHAMSON. Nor I.

Senator LEVIN. Or participant in any discussion?

General ABRAHAMSON. No.

Senator LEVIN. The next question has to do with the memorandum of understanding approach in dealing with our allies.

Is there any discussion with our allies as to the amount of dollars which will be flowing to them under the SDI Program if they reach an agreement with us?

Mr. PERLE. Absolutely not.

General ABRAHAMSON. That kind of approach was very firmly rejected.

Senator LEVIN. So that our allies do not know they will get dollar one if we sign an agreement with them?

General ABRAHAMSON. That is correct. However, there are some small contracts that we have been using, what I have called pathfinder contracts, where we already know that there is a benefit. So, to say that they do not know that they will get dollar one——

Senator LEVIN. I am talking about additional dollar ones.

Are you saying we have not represented or implied to our allies that there will be any additional bucks going to them if they sign this memorandum?

General ABRAHAMSON. No. But in order to be absolutely accurate, I do want to say that we have been discussing with them some potential experimental projects of the kind that could help iron out any problem. But these are in areas we now know are likely to be a clear benefit and there would be, in fact, a clear cost advantage or a research advantage.

So, there have been those kinds of discussions. Those would be very limited numbers of dollars.

Senator LEVIN. How many dollars are involved in those kinds of contracts with the British?

General ABRAHAMSON. I have not added all of those up, but my guess is we are not talking more than in our first ones, maybe less than tens of millions of dollars.

Senator LEVIN. Less than $100 million?

General ABRAHAMSON. Yes.

Senator LEVIN. Secretary Perle, let me ask you the same question.

Have we in any way implied to our allies with whom we are negotiating these contracts that there would be specific amounts or even general amounts of additional dollars going to them if these contracts are entered into?

Mr. PERLE. No, we have not. Let me say that all these agreements provide for is a framework in which we can cooperate. They are not, in my view, giving us anything that would justify such an implication.

Senator LEVIN. Will the contracts with allied firms or governments be subject to the same rules of competition as applies to contracts with American firms?

General ABRAHAMSON. The answer is yes.

Senator LEVIN. So that general rules relative to competition and advertising will apply to all contracts and we will not in any way modify those rules in these memorandums of understanding?

General ABRAHAMSON. That is correct.

I would point out in our general rules there are applications where it is advantageous to go sole source and there may be indications at some time to do that.

Senator LEVIN. I understand there are cases where we go sole source. Those rules and criteria are the same for going sole source to allied firms or governments as they are to American firms or government?

General ABRAHAMSON. Yes.

Senator LEVIN. Can you list for us, General, the areas which Secretary Weinberger was referring to this morning when he indicated that we have made unexpected early research breakthroughs?

Can you list those breakthroughs for us, the unexpected ones?

General **Abrahamson**. As I've testified several times before different committees we think one of the very important areas that we have proceeded much faster than we expected was in the free electron laser. I have indicated that. That was particularly important in light of our emphasis on boost phase weapons.

Where we have achieved what I consider to be a real breakthrough is in the area of being able to compensate for atmospheric distortion because it does not do any good to have a free electron laser on the ground unless you can get that energy up in the atmosphere.

There are related things like that.

Senator **Levin**. Can you give us for the record the unexpected early breakthroughs?

General **Abrahamson**. Yes, sir, I shall, but I would like to point out that a breakthrough is a very dramatic word. Frankly, it is a little hackneyed in our society at this point in time.

I think we have some that are real breakthroughs. I think we also have some that are properly classified as very substantial, very gratifying process that has come much faster than we indicated.

[Additional information follows:]

Significant Technical Progress

In the past year we have had some genuine breakthroughs and seen progress beyond that which was expected. For example, in the Directed Energy Field, work with atmospheric compensation technologies has progressed to the point where it appears that the potential for large, effective ground-based lasers is very real. This has important ramifications on survivability as well as lethality, two of the program's more important criteria.

Research with Free Electron Lasers (FELS) has progressed far more rapidly than anticipated with the possibility of jumping years ahead of what had been foreseen. In addition, tests of the MIRACL Chemical Laser, the free world's highest power laser, against a static Titan booster section demonstrated graphically the lethality of laser technology.

Advancements in the more mature Kinetic Energy Weapons (KEW) has also been significant. Electromagnetic launchers, or "rail guns," may offer the possibility of firing small projectiles at extremely high speed that would home in on, destroy a booster warhead by impact. The ability to input high levels of power to these devices has been demonstrated far sooner than expected. This means that heavier projectiles could be used and/or higher speeds attained.

Senator **Levin**. I understood that was his word. Maybe it was not the Secretary's word.

General **Abrahamson**. There are some generally in that category, but there are others that are also important that are not in that category.

Senator **Levin**. I recently submitted to you some questions which I believe are in the process of being answered.

Are you familiar with those questions? I do not want to duplicate those here.

General **Abrahamson**. No, I am not.

Senator **Levin**. Are they on the way back to me.

General **Abrahamson**. My staff indicates they are now in the works.

Senator **Levin**. Can you give us some idea when we will be receiving those?

General ABRAHAMSON. Early next week, sir.

Senator LEVIN. Thank you.

Secretary Perle, as I understand the conversations that the President had with Mr. Gorbachev, he told him, we are going to share this with you, we are going to do this mutually. We are going to move to a defensive system.

Frankly, I do not disagree with that. As a matter of fact, I think a real benefit from SDI is the possibility that we could move mutually to defensive systems. One of the reasons why I supported SDI at what I considered to be a reasonable level is that I believe it could have a very great positive spinoff some day, to achieve that goal someday provided it is done mutually.

Gorbachev said, "How do we know it is going to be done mutually? You say you want to give it or sell it to us. How do we know that will be the position of the next President. How do we know?" He keeps asking.

What is the answer? How would they know? Would you have any objection to our putting in the authorization bill a guarantee that the offer would be made at some date and the conditions which would be attached to it?

Would that be something the administration would work with us on and make that offer as part of the American law?

Gorbachev did not say, "How do we know you will not change the law?" At least we have done something in that area.

Would you work with us to put into law the conditions under which we would offer to the Soviets any system after it is proven feasible to try to answer Mr. Gorbachev's question, "How do we know?"

Mr. PERLE. I do not think it would be wise to put in statutory form an issue that should be the subject of negotiation. Obviously, what we are prepared to do in the defense area in the future depends importantly on what the Soviets are expected to do with respect to offensive weapons.

Senator LEVIN. Thank you.

Senator QUAYLE. Senator Nunn.

Mr. PERLE. I have to depart to a meeting.

On the question of the restrictive interpretation, I think it is misleading to talk in terms of the date at which the restrictive interpretation would become an incumbrance.

I think the restrictive interpretation is already an encumbrance and because we believe it is a wrong interpretation of the treaty, it would be most unwise, in my view, to legislate the restrictive interpretation.

I understand that there may be consideration given to doing so. We are now conducting the program under the restrictive interpretation which was the only interpretation of which we were aware when the program was structured.

We have now concluded, the President has concluded, that we are legally entitled with respect to those systems based on other physical principles, to carry out research and development and testing.

You could keep the program under the restrictive interpretation forever. If we were to do so, even if we were to make significant technical progress, you would have at the end of the day a collection of subcomponents that had been tested and developed that could not be integrated into a complete system and could not be tested as a complete system.

Senator, I frankly doubt that this committee would authorize any administration, and it will be some successor administration, to proceed with deployment of a system that had never been tested, that had never been integrated and put together in a system so that the effectiveness and performance and cost of which could reasonably be measured and the consequences of which could reasonably be assessed.

That is why it seems to me to restrain ourselves over the long term unilaterally to an interpretation of the treaty that we believe is not legally valid would prejudice the prospects for bringing to Congress at some point in the future a proposition on which the Congress could reasonably be expected to make a sound and responsible judgment.

Indeed, I do not see how an administration could make a sound and responsible judgment on the basis of subcomponents that had never been integrated into a system. So, it is not a question of the date on which you run up against the restrictive interpretation. It is a question of the philosophy with which you approach a very complex research and development program.

So, I would very much hope that Congress would not legislate the sort of restrictions that would make it far more difficult for this or any other administration, this or any other Congress, to make intelligent, informed decisions about the strategic effectiveness and cost effectiveness of a defense that we might be able to develop at the subcomponent level, but that, we could only confirm in a usable sense with an integrated program of development and testing.

Senator NUNN. My questions have nothing to do with any legislative goals. Terms of legislation and interpretation of the ABM Treaty, I do not have that in mind. Someone else may. I have not studied that issue.

But there is a relevant question in authorizing the money, as General Abrahamson laid out, as to what stage we are going to breach that narrow interpretation because Congress, as both of you mentioned, will at that stage want to be fully informed and that will be a question that we have to decide, Congress or someone will have to decide if we are to authorize and appropriate funds if the provision used would be in effect in accord with the broader interpretation, but a breach of the narrow.

To that purpose the date would become extremely relevant. We will be asking that question about the date each and every year as we go into the authorizations because it is right on the point of whether we have ratified the treaty, which occurred before I got here, that everyone has been proceeding on, including what you just said when you threw out the SDI Program, it was your thought and everyone's thought that the narrow interpretation applied.

That was Congress' thought when it ratified the treaty. When you ratify one instrument and find out what you ratified is not what you thought it was some 15 years later, the date at which that would be breached in terms of its original purpose becomes extremely relevant to the Congress and to the relevant committees on appropriations and authorizations.

Mr. PERLE. I was here when that ratification debate took place. I must say it did not explore in any detail these issues bearing on other physical principles because they seemed so distant at the time.

Other things were said in the course of that ratification debate about the circumstances under which we would withdraw from that treaty, and we have not done so. So, if the Senate had anything in mind when it ratified that treaty, it was that we would not continue to be bound by that treaty if the Soviets achieved a capability to attack and destroy our land-based forces during the period in which that treaty and its associated interim agreement was in effect.

So, the assumptions of 1972 have long passed, but it does seem to me it is incumbent upon us to examine the treaty and make some judgments about what we intended in the treaty, what the words of the treaty say, and what a reasonable interpretation of those words in the treaty would be.

We have now done that. I am sorry to say successive administrations did not do it very carefully. But having done it and having come to the conclusion that the treaty does permit testing and development of systems based on other physical principles, a decision to be bound permanently to the more restrictive interpretation when the Soviets are not bound to that interpretation would constitute a unilateral inhibition on our program, an inhibition that in the long run I think will make it impossible for us to make an intelligent decision about whether to proceed to deployment.

That is the only point I want to make. You are voting very large sums of money for this program. I think it is reasonable to satisfy yourselves that this money is going into a program that can be brought to fruition.

Senator NUNN. We are assuming that General Abrahamson will tell us if he runs into any problems with the narrow interpretation. His testimony, I understand, is that he has no problem with the narrow interpretation.

General ABRAHAMSON. At this point in time.

Senator NUNN. At this point in time or in the near term?

General ABRAHAMSON. Or in the near term.

Let me add something, sir, about what you just said that I think is going to be very important. If the Congress is going to ask that question repeatedly as part of the appropriations process, then I believe what I am going to have to do is what I have done up to this point and that is to examine very carefully and to say, what is the shortest, most direct route.

Senator WARNER. I might say less expensive because you are reaching that juncture where to go for a broader interpretation is less expensive.

Is that not correct?

General ABRAHAMSON. There will be that time. As I indicated, I have not done all of that kind of planning. It is an appropriate question, I do not disagree with you, but what it does say is that I will have to then undertake a continual reexamination of the program to see where the savings might be achieved if we do go in a more direct route. I have not done that to date.

Senator **Warner**. I think you should. That would be a savings in time as well as in dollars.

General **Abrahamson**. Yes.

Mr. **Perle**. If the purpose of the program is to arrive at a point where a decision should be made whether to deploy a strategic defense, there is no doubt it would be vastly cheaper and much faster to do so under the broad interpretation of the treaty than under the narrow interpretation.

Senator **Warner**. The word "vastly" is used calculatedly?

Mr. **Perle**. Yes, sir.

Senator **Nunn**. You could add that it would be much cheaper and faster if you had no treaty at all.

Mr. **Perle**. I think the restriction on deployment is not as significant an inhibition as the decision to deploy.

Senator **Nunn**. Are you saying that the treaty under the broad interpretation in no way impedes the SDI research and development with respect to those systems based on other physical principles? I thought General Abrahamson said that we would have to have an amendment to the treaty.

General **Abrahamson**. To go into the deployment phase, sir.

Senator **Nunn**. With a broad interpretation, you would never need an amendment until such time——

General **Abrahamson**. For those items. I am not a lawyer, sir. I am repeating now what is a legal interpretation, as I understand it, from the legal counsel and groups of people who have examined this, both in the State Department and in the Department of Defense.

Under those conditions if we can proceed into the development phase for other physical principles, then, yes, sir, it is correct that we, for the portion of the system someday that might be restricted only to other physical principles, could go directly.

However, to go beyond development and testing to a deployment is not included in that broader interpretation of the treaty.

Senator **Warner**. One last observation.

General **Abrahamson**. Am I being clear or being accurate? Are you following what I am saying, sir?

Senator **Nunn**. I believe I followed it.

General **Abrahamson**. I am not trying to be fuzzy.

Senator **Nunn**. I recognize that. I am not sure that you and Mr. Perle have said the same thing, but that is all right, too.

Senator **Warner**. If I can summarize because you and I discussed it a number of times privately and I think on one occasion in a public hearing. By pursuing a less restrictive interpretation of the ABM we will have:

One, a less costly program.

Two, you will get there faster.

Three, my recollection is that we probably would get a better, a more fully developed and more effective SDI.

General **Abrahamson**. I believe that is the case. When one must proceed into that, of course, is an open question at this point in time.

Senator NUNN. One final question on this point. You say you have not examined that yet, but you also said, you know, the question of cost and time lag. You also said you see no impediment with the narrow interpretation in the short term.

General ABRAHAMSON. Yes.

Senator NUNN. I guess the thing that is fuzzy, in my view, is are you sure there is no impediment with the narrow interpretation in the short term or is it because you have not looked at that?

General ABRAHAMSON. Remember, the program was structured on the narrow interpretation. So, the indepth kind of thinking that we have done, the indepth kind of planning, is based on the narrow interpretation.

What I indicated was that it is very proper now to begin to go into some very careful and detailed, indepth planning on a broader basis to see if that is in fact a careful—right now it is a judgment. It is not a carefully examined situation.

Senator NUNN. You say we could be spending more money and taking more time right now at the moment than we would otherwise take if the President had made the decision to go to a broader interpretation.

General ABRAHAMSON. I think that is a possibility. However, that possibility will grow as time goes forward and as we get into more integrated experiments. That was the basis of my earlier answer that I think we are several years away from a significant impact.

Senator WARNER. Senator Exon.

Senator EXON. I am going to change the subject a little bit because we have dwelled on this a long, long time. This spring several Senators were in Paris and we had a very interesting discussion with then Defense Minister Hernu. He was telling us about the French Eureka Program.

I am wondering what has happened to the Eureka Program since then. At that time he did not seem to think there was much compatability between our SDI and their Eureka Program. The French intend to proceed with Eureka and gave some indication that Bonn might join them in that.

What has happened to the Eureka Program? How does it differ from SDI and is there a chance of melding the two programs together?

General ABRAHAMSON. First of all, I believe that the Eureka Program is an evolving program, obviously. It is evolving in terms of agreement between government on funding and the technical concept behind it.

It is a program whose principle objective is to carry out research in certain particular areas. Some of those areas, but not all, many of those areas have some applicability to SDI in the sense if their work on computers and software programs were mature, that might help us.

By the same token if our work on computers and software and applications for our defensive systems were mature, that would probably help them. So, I have indicated publicly that I did not feel that there was significant competition between the two programs. In fact, I thought there may be some similarity between the two programs.

There is a possibility, however, that at some point in time there may be a particular research team or a particular effort that we would prefer that they give the priority to a defensive SDI application as to one of those. But I do not know of any of those now.

In general, I think those are reinforcing kinds of technical efforts and not in competition, as has been expressed all too often and I believe erroneously, in the press. I have talked directly with the Director of the Eureka Program.

Senator EXON. Is there general cooperation between you and your French counterpart?

General ABRAHAMSON. No, sir. If you explain cooperation as have we extended our planning to the level at this point that we are coordinating investment, we have not achieved that point yet. I do not believe that the Eureka Program itself is mature enough yet that that is a good strong possibility.

Senator EXON. In the last 6 months has there been a softening of what at one time seemed to be the French and the German positions that they were not going to have too much to do with SDI and they were going their own way? Has there been a softening of that position?

Has there been a mellowing of that position toward melding our efforts?

General ABRAHAMSON. In the case of the Federal Republic of Germany, they have been interested enough to send the largest of the teams that has spent the most time trying to understand the conditions under which we would go forward, but even as important, to understand the technology.

Senator EXON. How about the French?

General ABRAHAMSON. In terms of the French, the French Government has said if companies prefer to come individually, they see no objection and they would assist, at least with the minimum level of government-to-government agreement, and the one level we must have is security.

In fact, that process is happening. So, I think that in general there is a melding. But at the French Government level there has not been an embracing of SDI in an overarching agreement on something of that kind at this point.

Senator EXON. Is there a possibility that some of the SDI money that we are trying to get appropriated here might end up in French companies' hands for research and development?

General ABRAHAMSON. There is a possibility, sir, if it is cost effective and if they have competitive ideas that would assist us.

Senator EXON. Thank you, General.

Thank you, Mr. Chairman.

Senator WARNER. Senator Levin has a question or two and then we plan to go into executive session.

Senator LEVIN. Thank you, Mr. Chairman.

General, when we started this program it was your position that we determine SDI's feasibility under the then interpretation of the ABM Treaty.

General ABRAHAMSON. Yes.

Senator LEVIN. Is that still your position?

General ABRAHAMSON. I tried to explain——

Senator **LEVIN**. Is it still your position we can determine feasibility under the narrow interpretation?

General **ABRAHAMSON**. Yes, sir.

Senator **LEVIN**. It will cost us more and take longer?

General **ABRAHAMSON**. It will take more of your individual time to understand the implications of the technology.

Senator **LEVIN**. I understand all that. Nonetheless, it is still your view that we can still determine its feasibility under the narrow interpretation?

General **ABRAHAMSON**. Probably at a lower confidence level.

Senator **LEVIN**. Let me try to get a straight answer.

General **ABRAHAMSON**. I am giving a straight answer, sir. I am saying the answer is yes.

Senator **LEVIN**. You can attach all the conditions you want?

General **ABRAHAMSON**. The condition is that there probably will be a lower confidence level.

Senator **LEVIN**. I understand that. It will take us longer, it will cost us more, it will be a lower confidence level. It was justified.

When you started out, in your view, you never would have started out even though we were operating under the narrow interpretation; is that correct?

General **ABRAHAMSON**. Yes.

Senator **LEVIN**. Is it still justified under the narrow interpretation of the ABM Treaty with the conditions you set forth?

General **ABRAHAMSON**. I believe it is justified.

Senator **LEVIN**. If you knew right now we were going to be continuing to operate under the narrow definition of the ABM Treaty, you would still recommend we proceed?

General **ABRAHAMSON**. Yes, sir, because I believe in the program.

Senator **LEVIN**. How much cheaper will it be if we decide that the broad interpretation of the ABM Treaty is the one we want to follow?

General **ABRAHAMSON**. Sir, I am sorry, but I cannot give you a responsible answer. I have not calculated that or tried to deal with it. That will be a very difficult subject. As I indicated, it takes planning, it takes an understanding. It will probably be like the rest of the SDI Program, an evolving number.

Senator **LEVIN**. You are unable to tell us right now?

General **ABRAHAMSON**. I am unable to tell you now.

Senator **LEVIN**. Can you tell us how much faster we will know the feasibility?

General **ABRAHAMSON**. No.

Senator **LEVIN**. You are the head of the program. You cannot tell us how much faster, how much we will save under the broader interpretation?

Secretary Perle used the word "vastly."

STATEMENT OF FRANK GAFFNEY, DEPUTY ASSISTANT SECRETARY FOR INTERNATIONAL SECURITY POLICY

Mr. **GAFFNEY**. May I add a point on that.

Senator **LEVIN**. He is not here to defend himself.

Mr. **GAFFNEY**. At your request, I am substituting for him.

Senator **Levin**. The head of the program says it is irresponsible on his part to tell us how much we would save, how much faster it would be. Yet we have the Secretary telling us it would be vastly cheaper, vastly faster.

Mr. **Gaffney**. I think the third element is at least as important as the first two elements. The three criteria that General Abrahamson just mentioned:

The first criteria is the cost.

The second criteria is the amount of time.

The third criteria is the level of confidence.

The analogy has been offered—and I think it is a useful one—that if someone came to you and said I have built the fastest, most glamorous sports car in the world and here it is, and laid out for you all of the component parts from spark plugs to lug wrenches to axel rods and said, "How much will you give me for it? You will love it," I think your reaction would be that you want to test drive it—very similar to the kind of reaction you would have if the narrow interpretation is applied throughout the program.

That is not at all to say that the gentleman in question could not persuade you that that is in fact the world's most advanced sports car and particularly, as General Abrahamson has said, if the requirement, what you are talking about is your national security and not just touring around the countryside, you may want to go ahead on that basis even with the lack of confidence.

Senator **Levin**. I think the tone is so different. We have the head of the program who says it is irresponsible to say how much cheaper and how much faster.

We have the Assistant Secretary telling us it would be vastly cheaper and vastly faster.

General **Abrahamson**. My responsibility is to try to give you accurate cost estimates and accurate time estimates.

Senator **Levin**. I applaud you for your care. Frankly; I think you are exactly right in saying it will take a lot of time. I agree with you.

I do not know how Secretary Perle can say it is going to be vastly faster and vastly cheaper.

Senator **Warner**. Now we have a situation where our distinguished ranking minority member must leave. He is anxious to propound at least one question in executive session. We will now go into executive session.

Thank you very much.

[Whereupon, at 4:25 p.m., the subcommittee proceeded in executive session.]

EXECUTIVE SESSION

The subcommittee met in executive session, pursuant to other business, at 4:25 p.m., in room SR-222, Russell Senate Office Building, Senator John W. Warner (chairman) presiding.

Present: Senators Warner, Nunn, Exon, and Levin.

Staff present: Robert G. Bell, Robert F. Bott, Douglas R. Graham and Drew A. Harker, professional staff members; Karen A. Love, staff assistant.

Also present: Romie L. Brownlee, assistant to Senator Warner; James M. Bodner, assistant to Senator Cohen; and Henry D. Sokolski, assistant to Senator Quayle.

Senator WARNER. We are now in executive session. I yield first to our colleague from Georgia, Senator Nunn.

Senator NUNN. I have one question here about information. We are trying to get the ABM negotiating record, and so forth. I would like, Mr. Gaffney or General Abrahamson—a 1985 report on ABM Treaty negotiations prepared by Systems Planning Corporation, done for the Department of Defense. The number I have is STC-Log 85-0704.

The author, I believe, is retired Colonel Fitzgerald. It is supposed to be on the ABM Treaty. I do not know if it is classified or not. If so, we will take it under the proper classification.

Mr. GAFFNEY. I will take your question for the record, if I may. I am not familiar with the document.

Senator NUNN. Could you get back to us and let us know about it?

Mr. GAFFNEY. Yes.

[The information follows:]

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE,
Washington, DC, April 18, 1986.

Hon. SAM NUNN,
U.S. Senate, Washington, DC.

DEAR SENATOR: This responds to your request to me and to Richard Perle for documents relating to the negotiations of the ABM Treaty, i.e., the SPC study performed by Col. Charles Fitzgerald.

As you may know, a similar request was made of the State Department by the Senators Warner and Hart. The State Department has responded by proposing that Judge Sofaer, Ambassador Nitze and ACDA General Counsel Thomas Graham meet with interested Senators and informally discuss the negotiating history of the Treaty and the Administration's analysis of that history in our interpretation. Copies of the State Department's letters are attached.

We believe the meeting being arranged by the State Department would permit you and other Senators to obtain answers to your questions without interfering with the Executive Branch's perogatives. The State Department will be in contact with you concerning the arrangements for the meeting.

FRANK J. GAFFNEY, Jr.,
Deputy Assistant Secretary of Defense,
Nuclear Forces and Arms Control Policy.

Attachments.

U.S. DEPARTMENT OF STATE,
Washington, DC, April 11, 1986

Hon. JOHN W. WARNER,
Chairman, Subcommittee on Strategic and Theater Nuclear Forces, Committee on Armed Services, U.S. Senate.

DEAR MR. CHAIRMAN: The Secretary has asked me to respond to your letter of January 14, 1986 requesting access to various documents relating to the ABM Treaty. As I indicated to you in my letter of February 5, 1986, our delay in responding has been caused by the need for coordination among the various agencies that received similar letters from you. This letter is being sent on behalf of the Department of Defense and the National Security Council, in addition to the Department of State.

As your letter acknowledged, a request to examine the negotiating record of a treaty raises sensitive issues regarding the integrity of the negotiating process. At the same time, we recognize the Senate's interest in reviewing the manner in which the Executive Branch engages in treaty interpretation.

State Department representatives have met on two occasions with Armed Services Committee staff members in an effort to reach an accommodation in this matter. Based on those discussions, we propose to proceed in the following manner. Ambassador Paul Nitze, Legal Adviser Abraham Sofaer, and ACDA General Counsel Thomas Graham would be pleased to meet with interested members of the Subcommittee on Strategic and Theater Nuclear Forces in an informal, off-the-record session to discuss the negotiating history of the ABM Treaty and the Administration's analysis of that history in our recent interpretation of the Treaty. The Administration representatives would attempt to answer the Senators' questions on the negotiations (if necessary, by reference to particular documents that they would bring with them), but would not make the negotiating documents themselves available to the Senators. With regard to documents that you requested other than the negotiating record (including various internal memoranda and directives, both contemporaneous with and subsequent to the negotiations), the Administration representatives would be able to discuss those documents, as appropriate.

We are hopeful of resolving this matter in a manner that satisfies the Senate's legitimate concerns. We believe that the session we have proposed would do that. Please have your staff contact Eileen Giglio in my office to arrange the meeting.

Sincerely,

JAMES W. DYER,
Acting Assistant Secretary
Legislative and Intergovernmental Affairs.

U.S. SENATE,
COMMITTEE ON ARMED SERVICES,
Washington, DC, January 14, 1986.

Hon. GEORGE SHULTZ
Secretary of State,
Department of State, Washington, DC.

DEAR MR. SECRETARY: Since the announcement that the Reagan Administration had conducted a review of the 1972 ABM Treaty limitations on exotic technologies, there has been considerable interest among members of the Strategic and Theater Nuclear Forces Subcommittee in the documentation that supports the conclusions reached by the Administration.

In a hearing before the Subcommittee on this subject, witnesses on both sides of the issue cited sources that would be helpful in our understanding of the basis for the Administration's decision. Of particular interest is the negotiating record for the period of time during which the ABM Treaty was negotiated.

In addition, we understand that there are memoranda during this same period documenting Presidential decisions related to limits on "exotic technologies"; a draft memorandum—authored by John Rhinelander in the Spring of 1972—which purports to explain the ABM Treaty limits in detail and Department of Defense Directive(s) relating to ABM Treaty compliance.

We are asking your assistance in arranging for the Subcommittee or certain of its members to have access to the ABM Treaty negotiating record, which we understand is held by the Department of State. Recognizing that our access to these documents may raise issues related to the confidentiality of the negotiating process, it would be our hope that your staff could work with the Subcommittee staff to fashion an arrangement that will be satisfactory for all concerned.

It would be most helpful if members of the Subcommittee who have an interest in the contents of these documents would be able to satisfy their interest prior to our consideration of the FY 1987 request for the Strategic Defense Initiative Program. We have asked Bob Bott, Doug Graham, and Bob Bell of the Committee staff to work toward that end.

Sincerely,

JOHN W. WARNER,
Chairman.

GARY HART,
Ranking Minority Member.

Senator NUNN. General Abrahamson, are you familiar with it?

General ABRAHAMSON. No, sir.

Senator NUNN. I have one question. Agreed statement G of the ABM Treaty forbids either side from providing other states technical descriptions or blueprints to assist for construction of ABM systems and components prevented by the treaty.

Will this restriction interfere with our allies, participation in SDI?

General ABRAHAMSON. The answer is yes, sir. It is clear that at the full component level that we are precluded from giving them certain components or, as a result, the blueprints in accordance with that.

Therefore, we have indicated to them that there are parts of the program that they will not be allowed to participate in. That does not mean that there are not meaningful parts that they can participate in and that will be important, but nonetheless, the treaty has to be abided by.

Senator NUNN. In your opinion, does the agreed statement G apply to ABM, based on other physical principles?

General ABRAHAMSON. Agreed statement D?

Senator NUNN. G, the one that forbids transfer to other countries.

General ABRAHAMSON. Of other physical principles? I think operating at the less than component level, this is where it really applies. In the treaty language when they talk about components, they are referring to and it is laid out quite specifically, in terms of components, it is a different language than we now use the word component.

For example, a component is a launcher or a component is a missile, itself, interceptor or a radar. The kind of discussions that we have been having with our allies are at much different levels. I can give you some examples of that.

By the way, that is why I felt that a closed session or portion of the overall program can give you a better feeling for the kinds of things we are doing.

Senator NUNN. Let me repeat that and then I will defer to you.

Does that mean that you believe that agreed statement G does apply to exotic ABM systems based on other physical principles?

General ABRAHAMSON. I would prefer not to answer that from the top of my head. I would like to give you a good responsible answer.

Senator NUNN. Fine.

Mr. Gaffney, Do you have an opinion?

Mr. GAFFNEY. I would like to take that for the record. I believe I can give you a fully coordinated statement.

[The information follows:]

ABM TREATY AND ALLIED PARTICIPATION IN SDI

Senator NUNN. Does agreed statement G (of the ABM Treaty) apply to exotic ABM systems based on other physical principles?

Answer. Agreed statement G construes article IX as obligating each party not "to provide to other States technical descriptions or blue prints specially worked out for the construction of ABM systems and their components limited by the treaty." Pursuant to Presidential direction, the SDI program was designed to answer our questions concerning effective strategic responses and is being conducted as originally structured which is consistent with the more "restrictive" interpretation of the Treaty. Under that interpretation, ABM systems or components based on other physical principles are "limited by the Treaty," and we are therefore constrained by agreed statement G in cooperative activities with our allies.

Senator NUNN. At this stage, General, you have not negotiated with the allies on any of these other physical principles, contractor relationship?

General ABRAHAMSON. It may be helpful for you to understand some of the kinds of things. Let me give you an example of some of these.

For example, in discussions with Germany, Germany has some very, very advanced capabilities in neutral particle beam ion generators. Now, we are talking about things that are advanced capabilities. Some of those are different than what we are using right now.

We are seeing at several places, including the University of Darmstadt and several other German institutions, that they have different concepts in some cases that may be useful. For example, an electrode plating technique which is a problem in linear accelerators.

So, you see the level of some of these kinds of things that we are talking about.

In other cases, at the German Cyclotron Laboratory they have a whole structure of three-dimensional computer codes that are very important for progress in just basic atomic and nuclear theory and in this case can be applied to some of the things that we are doing. In this case the transfer is not from us to them, it is from them to us.

Those are some of the examples. That is not the only kind of examples, but those are some. I hope it illustrates a little bit some of the levels. [Deleted.]

It does show you that we have a team that has taken some slightly different approaches and it is worthwhile looking at.

[Deleted.]

Now, there are some examples of where you go the other way. Remember, I showed you the example of the electromagnetic rail gun where if applied in a different way, that fundamental technology can be used for intermediate-range ballistic missiles and perhaps for aircraft interception as well. But it is applied in a different way than we are now looking at.

We have not accepted that, but that is an example of one where the technology flows the other way. I do not want to make this one of my normal technical briefings, by the way.

Senator WARNER. Are there portions of the direct testimony that you wish to give, Secretary Gaffney and General Abrahamson, in the executive session?

If not, we should proceed to questions.

Mr. GAFFNEY. I do not have anything.

Senator LEVIN. Could I interrupt with one question and then I will leave.

Senator WARNER. I will favor you with one question.

Senator LEVIN. It has to do with the negotiating record question. I believe our chairman asked for certain portions of the negotiating record.

Senator WARNER. I have been working on this request. The issue is with the NSC and with the sudden unanticipated shift in the NSC leadership.

General **Abrahamson**. One of the earlier questions by Senator Quayle had to do with the relationship between SDI technology and shorter range ballistic missile kinds of systems.

I indicated that we have done architectural studies and tried to look at where some of these relationships show. Here is an example of where SS-21 burns out, SS-23 and SS-22, in terms of their altitude as they go forward, burn out in apogee.

Here are the results of a weapon study that indicates that space-based kinetic-kill vehicles can be effective down to the level where they may intercept not only [deleted] as we expect now, but they may also have some effectiveness in the midcourse against [deleted].

Obviously, they cannot be effective against [deleted]. On the other hand, certain types of chemical lasers with the right frequencies so that they can penetrate the atmosphere can get you down to these low altitudes so that you may be able to, in fact, intercept some of these things, if you have the time, in the proper boost phase part of the flight.

I could go through a large architectural briefing, but the point I wanted to illustrate with only one chart is that we have not ignored this question. We have been dealing with it as part of the architecture. In fact, the most efficient approach to a European or theater initiative of some particular kind is as a subset and as integrated into some of the SDI activities.

By the way, it will not only be the exotic weapon. In fact, there will be important weapons of the more conventional variety as well, such as these kinds of interceptors, perhaps an airborne fire control system and something that would be a high-altitude surveillance platform, but something flying in the air as opposed to in space alone.

I do want to point out there are efforts that are underway. I still do not characterize these as mature as some of our others.

In fact, that is one of the really important things because there is a technology base in Europe that may not have to be extended as far in order to begin to get direct benefits, and by having them involved in architectural studies, themselves, and evaluating their own technology base, we may be able to build on existing weapon systems or existing production lines and in that way begin the benefits earlier and quicker and less expensively.

Senator **Exon**. I have one question. Regarding European technolgy, I had assumed, maybe incorrectly, that French technologies may be ahead of the British or Germans.

Is that right or wrong?

General **Abrahamson**. It is very hard to generalize, but I would say that in certain of the space technologies it is clear that the French are ahead in certain categories. Let me give you an example.

Where we are working with composite materials and interested in the composites which are the materials like the ones we build the MX out of or some of the things we are looking for low-cost base structure, the French may be ahead of us in some areas.

Senator **Exon**. Have we received any information from the French similar to that we have received from the Germans and the British?

General ABRAHAMSON. We have had some informal discussions between ourselves and certain of the French people. I have talked informally to some high-placed Government people that I worked with while I was at NASA and certainly some of the companies have been very eager; in fact, the President of Matra said publicly on the day that President Mitterand announced the French Government would not participate, that Matra will.

Mr. GAFFNEY. The independent French spirit.

Senator WARNER. Secretary Gaffney, Mr. Perle is on record in favor of constraints on the export of military sensitive technology.

Will you describe for us some of the steps we might take to provide for allied participation in the SDI Program while providing for protection of sensitive technology?

Mr. GAFFNEY. I will be happy to, Senator.

I refer to firsthand experience in negotiating with the United Kingdom in terms of conditions which govern our cooperation, that there is a ready appreciation on the part of the European governments as well—I think as a result of administration efforts—for the dangers of legal and illegal technology transfers.

There is this danger associated with prospective SDI cooperation as well. However [deleted].

I think that is an important indication of one way to control technology transfer.

Another way, obviously, is derived from the way General Abrahamson's program, itself is being structured; that is, layering the levels of security associated with some of the most sensitive work. [Deleted.]

The most important thing is to make sure that the people involved in SDI are aware of the risks and act accordingly.

[Deleted.]

It seems to me that perhaps due to the limits of an open session, we might discuss the less than satisfactory answer to Senator Nunn's question about flexible response, the strategy and the underpinning of our current deterrent posture. I would like to take a minute in closed session to elaborate on some of the answers.

I think the most important point that he made is that we are talking in the SDI program about the long-term process, a process that will evolve—assuming the technology pans out—in an evolutionary decisionmaking process and introduction of systems that provide for defense of our allies and ourselves.

That, like the implementing of the flexible response strategy in the first instance, is a process of education and discussion and consideration by the allies and entails a great deal of give and take.

The first portion of General Abrahamson's submitted statement, which he did not read, is a useful treatment of this elaborative and collaborative process between allies. [Deleted.]

[Deleted.]

Thank you.

Senator WARNER. Gentlemen, we have had a most productive hearing. I would just like to chat informally.

[Questions with answers supplied follow:]

Questions Submitted by Senator John Warner

SOVIET TACTICAL BALLISTIC MISSILES

Senator WARNER. In your statement, you noted the threat to our allies posed by Soviet tactical ballistic missiles. In your judgment, is the technology for effectively defending against this threat sufficiently mature to support a near-term development decision, and is this an area where our allies bring considerable expertise?

General ABRAHAMSON. In addition to our examination within the SDI of defenses against shorter range as well as strategic ballistic missiles, NATO, with U.S. participation, is studying defenses against tactical missiles (ATM/ATBM) in conjunction with its effort to improve NATO air defenses. Our allies bring significant technical expertise to this subject, which involves a direct and growing Soviet threat to their territory. However, considerable technical and strategy work needs to be accomplished before decisions about development and deployment of ATBMs can be made.

ATBM SYSTEM

Senator WARNER. What work has been done to date on the anti-tactical ballistic missile (ATBM) system, and what actions would be required if we were to proceed with the development and deployment of an ATBM system?

General ABRAHAMSON. We are beginning analyses in our architecture studies to address the ATBM question. NATO is also studing the issue in the context of expanded air defense. Our allies have a particular concern with the growing nuclear, chemical and conventional threat from Soviet tactical ballistic missiles. There are no ABM Treaty limits on developing and deploying ATBMs, provided those systems do not have the capability to intercept strategic ballistic missiles or their elements in flight and that they are not tested in an ABM mode. However, before proceeding to develop and deploy ATBM systems, considerable technical and strategy work remains to be done to ensure that deployed ATBMs enhance security and stability.

SOVIET THREAT AND POSSIBLE ATBM DEVELOPMENT

Senator WARNER In view of the serious threat posed to high value NATO targets by Soviet tactical ballistic missiles, has the Department of Defense recommended that we proceed with the development and deployment of the anti-tactical ballistic missile (ATBM) system?

Mr. PERLE. Since the beginning, the President has stressed that because the security of the United States is inextricably linked with that of our allies, the SDI program would examine not only those technologies with applicability for effective defense against long range ballistic missiles that threaten the United States, but also those shorter range missiles that threaten primarily our allies. No development to deployment decisions have been made with respect to any defensive system.

Question Submitted by Senator Dan Quayle

SOVIET TBM'S AND NATO'S FLEXIBLE RESPONSE STRATEGY

Senator QUAYLE. Does the threat to key high value NATO targets posed by Soviet tactical ballistic missiles threaten to undermine the credibility of NATO's Flexible Response strategy and the "deep strike" strategy embodied in Air-Land Battle 2000?

Mr. PERLE. Yes. Soviet SS-20s, SCALEBOARDs and other shorter range ballistic missiles provide overlapping capabilities to strike all of NATO Europe. Moreover, Soviet doctrine stresses the use of conventionally armed ballistic missiles to initiate rapid and wide-ranging attacks on crucial NATO military assets throughout Europe. The purpose of this tactic would be to reduce significantly NATO's ability to resist the initial thrust of a Soviet conventional force attack (in part by degrading those assets necessary to activate a "deep strike" strategy) and to impede NATO's ability to resupply and reinforce its combatants from outside Europe. The Soviet Union's growing capability in this regard could have a very serious effect on NATO's ability to support its Flexible Response strategy.

Question Submitted by Senator Sam Nunn

Senator NUNN. When you say that, yes, the treaty will prevent us from providing our allies with blueprints of ABM components based on other physical principles, do you mean under the restrictive interpretation, the broad interpretation, or both?

General **Abrahamson**. Agreed statement G construes Article IX as obligating each party not "to provide to other States technical descriptions or blueprints specially worked out for the construction of the ABM systems and their components *limited by the treaty*" (emphasis added). Pursuant to Presidential direction, the SDI program has been designed to be conducted in accordance with the "restrictive" interpretation of the treaty. Under that interpretation, ABM systems or components based on other physical principles are "limited by the treaty," and are not to be provided to other states.

[Whereupon, at 4:50 p.m., the subcommittee adjourned, subject to the call of the Chair.]

APPENDIX

[The prepared statement of Mr. Sofaer, submitted at the October 30, 1985 hearing follows:]

Prepared Statement of Abraham D. Sofaer, Legal Adviser, U.S. Department of State

Mr. Chairman, and Members of the Committee: This is my first appearance before your Committee. I am honored by your invitation to discuss the meaning of the Anti-Ballistic Missile Treaty with respect to so-called future ABM systems or components, including some contemplated as part of the Strategic Defense Initiative.

The ABM Treaty is an important element of our strategic arms control structure. When the President first announced the SDI program in March 1983, he made clear that it would be conducted "consistent with our obligations [under] the ABM treaty." This commitment has been maintained. The United States has scrupulously complied with the Treaty, notwithstanding such clear Soviet violations of it as the Krasnoyarsk radar station.

Soviet violations of the ABM Treaty, the implementation of our SDI program, and the ongoing arms negotiations at Geneva recently caused various agencies to consider more thoroughly than ever before the appropriate interpretation of the ABM Treaty as it relates to future or "exotic" systems. By that, I mean defensive systems that serve the same functions as ABM systems and components, but that use devices based on technology not understood in 1972 when the Treaty was negotiated and that are capable of substituting for ABM interceptor missiles, launchers, and radars. This examination has led to the conclusion that a reading of the ABM Treaty that would allow the development and testing of such systems based on physical principles other than those understood in 1972 is wholly justified.

At the same time, however, I want to emphasize a critical point made by Secretary Shultz in his speech to the North Atlantic Assembly last week: "[O]ur SDI research program has been structured, and, as the President has reaffirmed [on October 11], will continue to be conducted in accordance with a restrictive interpretation of the Treaty's obligations." Secretary Shultz assured our NATO allies of "[o]ur commitment to pursue the program as currently structured, which is consistent with a restrictive interpretation of our obligations under the ABM Treaty." Accordingly, he described the debate over the two interpretations as "moot." The issue may have practical significance only when the SDI program has reached the point at which questions regarding the feasibility of strategic defense have been answered and engineering development, with a view to deployment, becomes a real option.

I was well aware when I began my work on this issue that several officials associated with the SALT I negotiations, and others still in the Government, had advanced the view that the ABM Treaty is unambiguous in its treatment of such future systems. They argued that Article V of the Treaty forbids development, testing, or deployment of any future ABM systems and components other than those that are fixed land-based. They read Agreed Statement D as relevant only to fixed land-based systems and components, arguing that it permits "creation" of such systems and components when they are based on "other physical principles," but conditions their deployment on agreement between the parties on specific limitations. Other persons were contending, however, that this "restrictive" view of the ABM Treaty is based on unilateral assertions by U.S. negotiators; that the Treaty is ambiguous; and that the negotiating record supports a broader view of our freedom to develop, test, and deploy future systems.

My study of the Treaty led me to conclude that its language is ambiguous and can more reasonably be read to support a broader interpretation. An examination of the three provisions primarily at issue will demonstrate why this is so. Article II(1) defines an "ABM system" as "a system to counter strategic ballistic missiles or their elements in flight trajectory, currently consisting of" ABM interceptor missiles, ABM launchers, and ABM radars. Article V(1) provides that the parties agree "not to develop, test, or deploy ABM systems or components which are sea-based, air-based, spaced-based, or mobile land-based." Agreed Statement D, a side agreement that accompanies the Treaty, provides as follows:

"In order to insure fulfullment of the obligation not to deploy ABM systems and their components except as provided in Article III of the Treaty, the Parties agree that in the event ABM systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars are created in the future, specific limitations on such systems and their components would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the Treaty."

The restrictive interpretation rests on the premise that Article V(1) is clear on its face: it says no development, testing, or deployment of "ABM systems or components" other than those that are fixed land-based. But this language does not settle the issue of the article's applicability to future systems or components. That issue depends on the meaning of the term "ABM systems or components": is that phrase limited to systems and components based on then-current technology, or does it also include those based on future technology?

In attempting to answer this question, one must turn to the definition of "ABM system" in Article II(1). Proponents of the restrictive view contend that this definition is functional: anything every conceived that could serve the function of countering strategic missiles in flight falls within the definition. These persons argue that the three components identified in that paragraph—missiles, launchers, and radars—are merely listed as the elements of what an ABM system is "currently consisting of," and that all future components of a system that satisfies the functional definition are also covered by Article II(1). Only when armed with these meanings can proponents rely on Article V(1) as a ban on development, testing, and deployment of all non-fixed land-based systems or components, whether current or future.

This reading of the Treaty is plausible, but it is not the only reasonable reading; on the contrary, it has serious shortcomings. The premise that Article II(1) defines "ABM system" in a functional manner, meant to include all future systems and components, is difficult to sustain. The provision can more reasonably be read to mean that the systems contemplated by the Treaty are those that serve the functions described and that currently consist of the listed components. The Treaty's other provisions consistently use the phrases "ABM system" and "components" in contexts that reflect that the parties were referring to systems and components based on known technology. Article II(2), for example, further describes the "ABM system components listed in paragraph 1 of this Article," to include those that are operational, being tested, under construction, etc.—thereby indicating that the definition in Article II(1) was not merely illustrative, but was intended to describe the actual components covered by the Treaty. To take another example, Article V(2) sets limits on the types of "launchers" that may be developed, tested, or deployed—thus reflecting in the same article as the alleged prohibition on future mobile systems and components, an exclusive concern for one of the current components listed in Article II(1).

Systems and components based on future technology are not discussed anywhere in the Treaty other than in Agreed Statement D. In that provisions, the parties felt a need to qualify the term—systems and components created in the future—with the phrase "based on other physical principles." If "ABM system" and "components" actually meant all systems or devices that could serve ABM functions, whether based on present or future technology, the parties would not have needed to qualify these terms in Agreed Statement D. That this qualification was added suggests that the definitions of "ABM system" and "component" in Article II(1) extended only to those based on presently utilized physical principles and not on "other" ones.

The existence of Agreed Statement D poses a fundamental problem for the restrictive view. Nothing in that Statement suggests that it applies only to future systems that are fixed land-based; on the contrary, it addresses all ABM systems and components that are "based on other physical principles." Moreover, the restrictive interpretation would render this provision superfluous. If Article II(1) extended to all ABM systems and components, based on present as well as on future technology, the Article III implicitly would have banned all future fixed land-based systems and components. Such an interpretation, by rendering a portion of a treaty superfluous, violates accepted canons of construction.

The serious difficulties of construction created by the restrictive reading are avoided if one reads Articles II(1) and V(1) as referring only to ABM systems and components based on currently utilized physical principles. Read in this manner, the Treaty establishes a coherent, non-redundant scheme that prohibits:

The deployment of all fixed land-based systems and components derived from current technological principles, except as specifically permitted (Article III);

The development, testing, and deployment of all mobile systems and components dervied from current technological princpiles (Article V(1)); and

The deployment of all forms of systems and components derived from "other" physical principles, until after agreement on specific limitations (Agreed Statement D).

Other reasonable constructions of the Treaty have been advanced, but I think that the arguments that I have presented serve to demonstrate the ambiguities present in the text of the ABM Treaty.

Under international law, as under U.S. domestic law, once an agreement has been found ambiguous, one must seek guidance in the circumstances surrounding the drafting of the agreement. Thus, in the present situation, once we concluded that the Treaty is ambiguous, we turned to the negotiating record to see which of the possible constructions most accurately reflects the parties' intentions.

Examining the negotiating record for the ABM Treaty presented some real, albeit mundane, difficulties. No single agency has systematically collected and preserved the entire record in a readily usable form. My staff and I therefore obtained from various sources everything that we could find that might be relevant to the issue of future systems and components. Becasue we are still in the process of collecting material, I cannot tell you with certainty that I know every single step in the negotiating process. But we are far enough along that I can say with confidence that a much stronger case exists in the record for the restrictive interpretation.

The entire negotiating record is classified, and I therefore cannot reveal any detail in open session. If, after this public session, the Committee chooses to go into executive session, I will be free to explain much more. I can tell you in general, however, that I personally reviewed all the significant statements and drafts in the available negotating history regarding future systems. I reached the firm conclusion that, although the U.S. delegates initially sought to ban development and testing of non-land based systems or components based on future technology, the Soviets refused to go along, and no such agreement was reached. The Soviets stubbornly resisted U.S. attempts to adopt in the body of the Treaty any limits on such systems or components based on future technology; their arguments rested on a professed unwillingness to deal with unknown devices or technology. The farthest the Soviets were willing to go with respect to such future systems or components was to adopt a side agreement prohibiting only the deployment of such systems and components, once created, until the parties agreed on specific limitations. The parties did not agree to ban development and testing of such systems or components, whether on land or in space.

The negotiating record also contains strong support for a reading of Article II(1) that restricts the definitions of "ABM system" and "components" to those based on current physical principles. The Soviets specifically sought to prevent broad definitions of these terms, and our negotiators acceded to their wishes. Moreover, our negotiators ultimately convinced the Soviets to adopt Agreed Statement D by arguing that, without it, the Treaty would leave the parties free to deploy systems or components based on other physical principles, such as lasers.

I am aware that some U.S. negotiators in the SALT I talks assert that they achieved a total ban on the development, testing, and deployment of all future mobile systems and components, including those based on other physical principles. The negotiating history contains suggestions as to why they reached their conclusions. But the record of the negotiations fails to demonstrate that they actually succeeded in achieving their objective. On the contrary, the record reflects that they failed to obtain the ban they sought, and that we could never have enforced such a ban against the Soviets. Treaties like other agreements, are enforceable only to the extent they create mutual rights and duties. In effect, because the Soviets succeeded in avoiding a broad binding commitment regarding the development and testing of mobile systems and components based on future technology, we cannot properly be said to be bound by such a commitment.

I wish to close by reiterating a critical point. Notwithstanding our belief in the merits of the broader interpretation, the President has decided to pursue the SDI program as currently structured, which can be accommodated within the confines of the "restrictive" interpretation—namely, research into, but not development or testing of, systems or components based on future technology and capable of substituting for ABM interceptors, launchers, or radars.

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